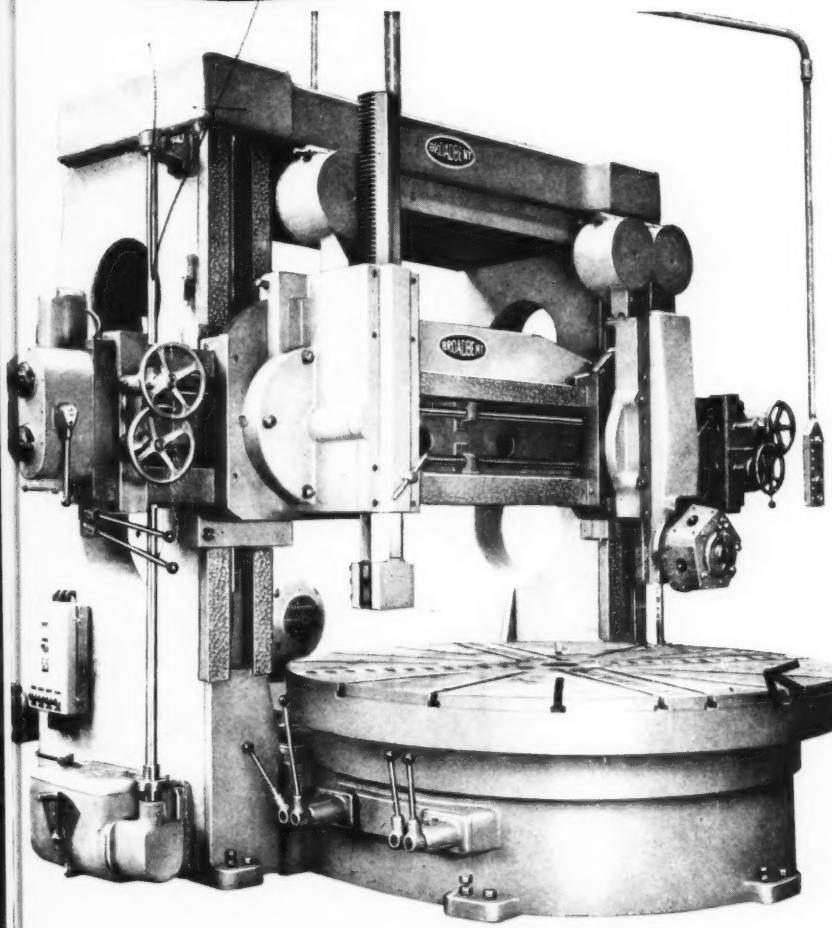
MACHINERY

DECEMBER 6, 1961 ONE SHILLING & THREEPENCE

BROADBENT

Heavy Duty Vertical BORING & TURNING MILLS



Massively constructed for years of hard service, Broadbent Mills give maximum accuracy and dependability with ease of control and minimum maintenance.

Every Broadbent Boring and Turning Mill incorporates 12 changes of speed and 6 changes of feed. Clutch and speed change can be controlled from either side of the machine. The table runs on a large diameter white metal Vee ring and is driven through spiral bevel and spur reduction gears. Either head, incorporating rapid power traverse, may be controlled independently. The rams and cross slides are operated from pendant control.

Please write for illustrated brochure.

5 ft. 6 ft. 8 ft. 10 ft. diameter worktables all with 12 speeds and 6 rates of feed

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MILLS
BRIGHT STEEL BARS

Rounds (drawn, turned and ground)
Hexagons, Squares, Flats,
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Mild, Freecutting, Casehardening,
Carbon and Alloy steels.
Supplied to A.I.D., Admiralty,
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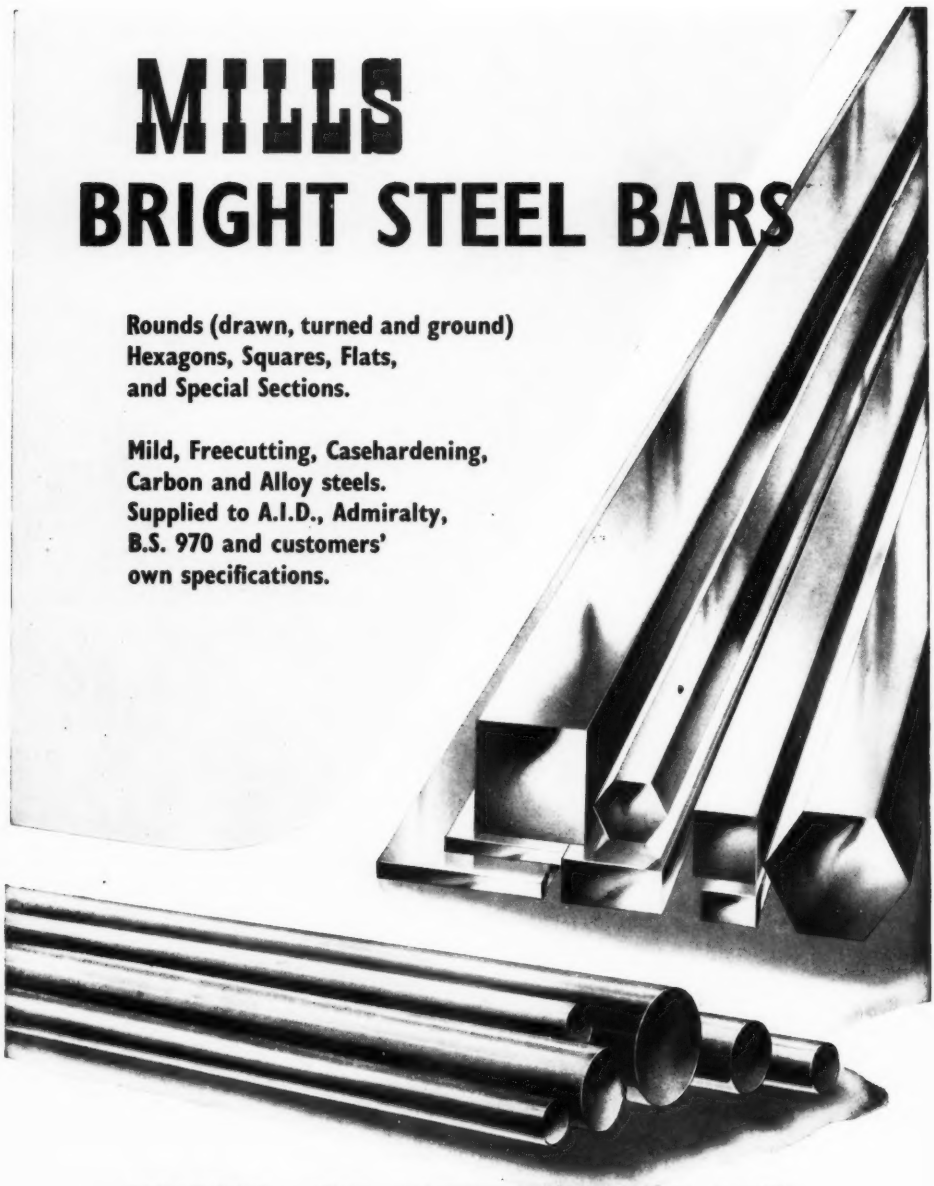

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BREDBURY STEEL WORKS WOODLEY. NR. STOCKPORT

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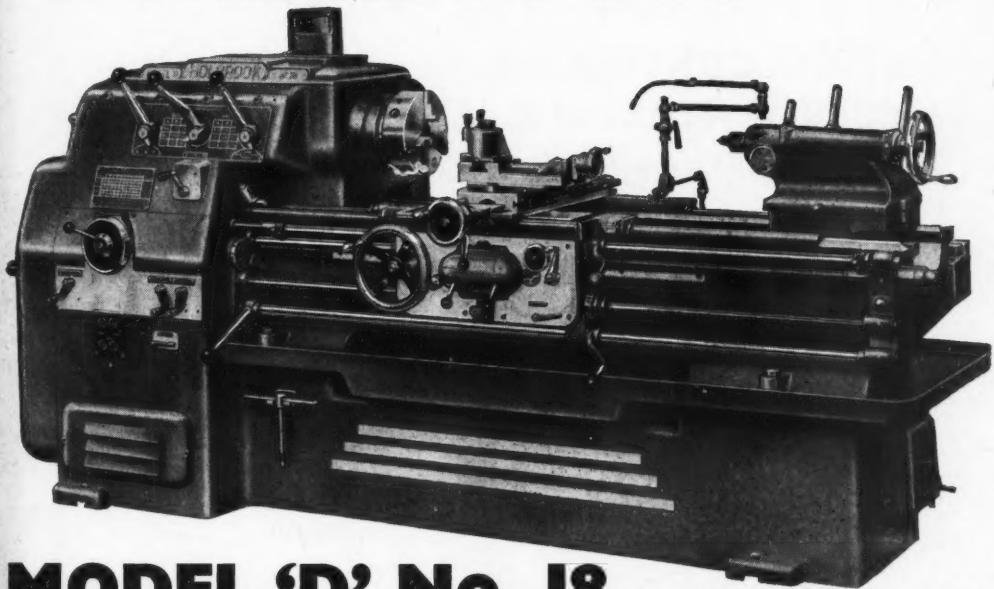
. . . . . 18 SPINDLE SPEEDS 15 TO 1000 R.P.M.



MODEL 'D' No. 18 NOMINAL CAPACITY 18" × 42"

PRECISION LATHES WITH . .

THE FOLLOWING FEATURES:—

CAM-LOCK SPINDLE NOSE
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BUILT-IN TAPERING EQUIPMENT
PRECISION LEADSCREW WITH COMPENSATING END THRUST
PRECISION GROUND COVERED BEDWAYS
60 THREADS & FEEDS : ELECTRIC SUDS SUMP
MECHANICAL PROFILING AND FULL RANGE ADDITIONAL EQUIPMENT AVAILABLE

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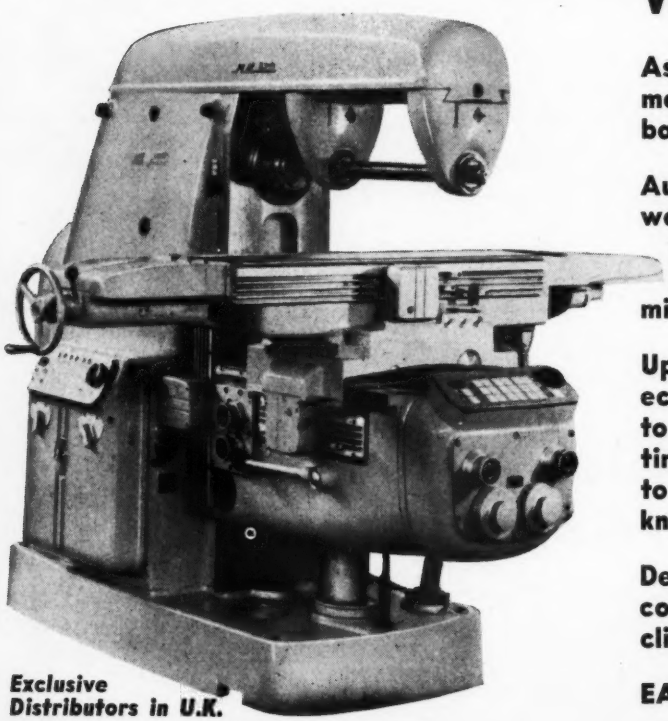
MODEL MUP 320

SWITCH CONTROLLED ELECTRO-HYDRAULICALLY OPERATED MILLING MACHINES HORIZONTAL & VERTICAL



Exclusive Distributors in U.K.

As suitable for medium as large batch production.

Automation with working cycles variable in a matter of minutes.

Up to 60-70% economy in floor to floor milling times compared to conventional knee-type machines

Designed for conventional and climb milling.

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MACHINE TOOL EXHIBITION

AT OUR EXTENDED SHOWROOMS

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A FULL RANGE
OF MACHINE TOOLS
DEMONSTRATED
UNDER POWER

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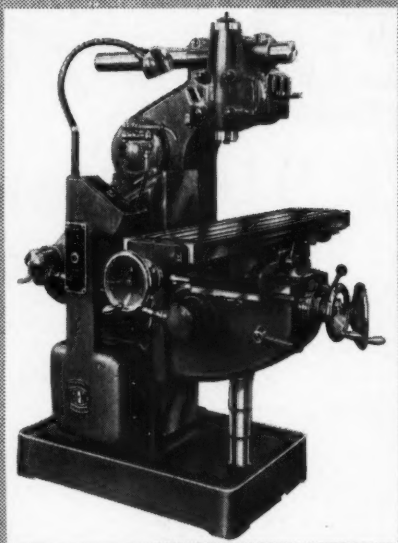
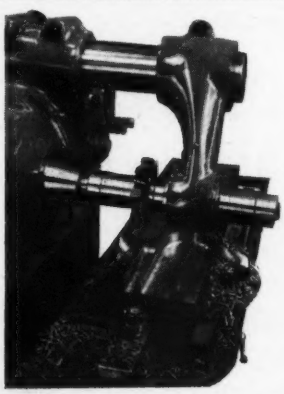
MMT

from Horizontal to Vertical Mill... in One Minute!

ABENE

COMBINED HORIZONTAL & VERTICAL MILLERS





Typical horizontal milling application on the Abene.

High speed with power feed and rapid traverse in all directions.
Combines the working capacity of vertical and horizontal milling machines.
Due to the inclined design the machine retains the maximum of 20" from spindle to table whether set for vertical or horizontal milling. Also manufactured as a model VHF.2B with power longitudinal feed only.

MODEL VHF.3.

Working surface of table	48" x 10"
Longitudinal and cross feeds	$\frac{5}{8}$" to 30" per min.
Vertical	$\frac{3}{8}$" to 18$\frac{3}{4}$" per min.
12 spindle speeds	44 to 2,000 r.p.m.
Motor	5 h.p.

MODEL VHF.2B

Working surface of table	41" x 10"
Longitudinal feed	$\frac{5}{8}$" to 30" per min.

Spindle at 45° on end milling job.

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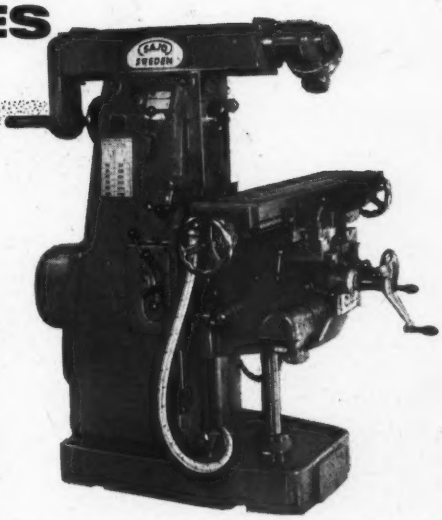
MEC

Engineered for Precision and Rigidity

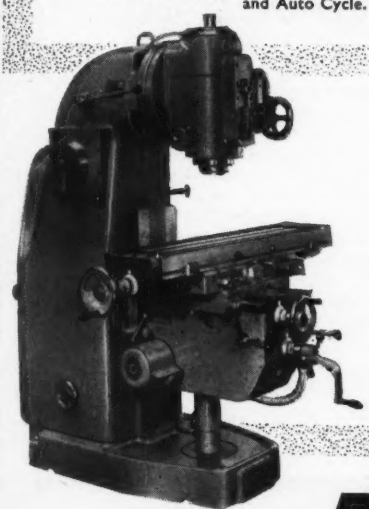
SAJO MILLING MACHINES



UF.52

with Toolmaker's Overarm

Special Overarm carries Universal Milling Attachment 1 : 1 ratio with normal spindle speeds, thus maintaining maximum height spindle to table.
12 spindle speeds 40 to 1,800 r.p.m.
Universal Attachment 1 : 1 ratio.
Working surface of table 41½in. by 9½in.
12 rates of feed: 35, 32, 30in. per min.
3½ H.P. spindle motor, ½ H.P. feed motor.
Also manufactured as standard Universal or Plain Machines and Auto Cycle.



VF.54

Power Feed to Swivel Head

Head swivels 45° left or right.
Power feed can be used with head either swivelled or in vertical position.
12 rates of power feed with rapid traverse on all table movements.
Working surface of table 52in. by 11in.
7½ H.P. spindle motor, 1½ H.P. feed motor.
Also manufactured as Plain, Universal and Auto-Cycle Machines.

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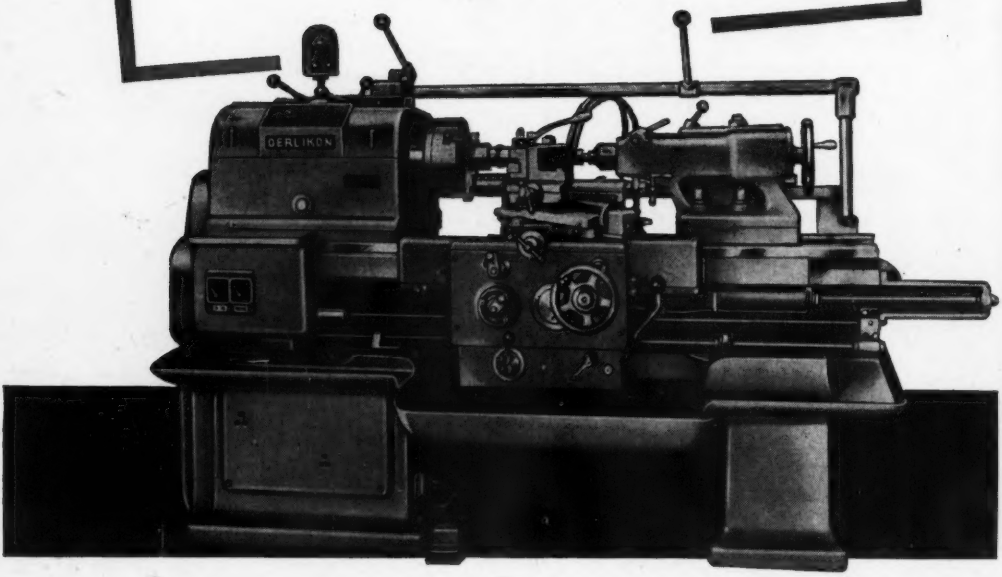

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OERLIKON

HIGH SPEED HYDROCOPYING LATHE MODEL DKO

With built-in hydrocopying system of unusual accuracy and sensitivity, the OERLIKON DKO is designed for rapid repetition copying of both external and internal profiles. Copying can be effected from cylindrical masters or simple, economical sheet steel templates. The machine can be used for normal production turning and facing also. The hydraulically controlled tailstock is adjustable for pressure and is provided with rapid advance. Automatic tool approach and longitudinal return traverse permit rapid operation and the tool holders are of the quick change type. Provision is made for power operation of the chuck.

Swing over bed 17¾". Turning length 23⅝".
Spindle speeds (13) 40 to 2500 r.p.m.

Send for illustrated brochure M/212

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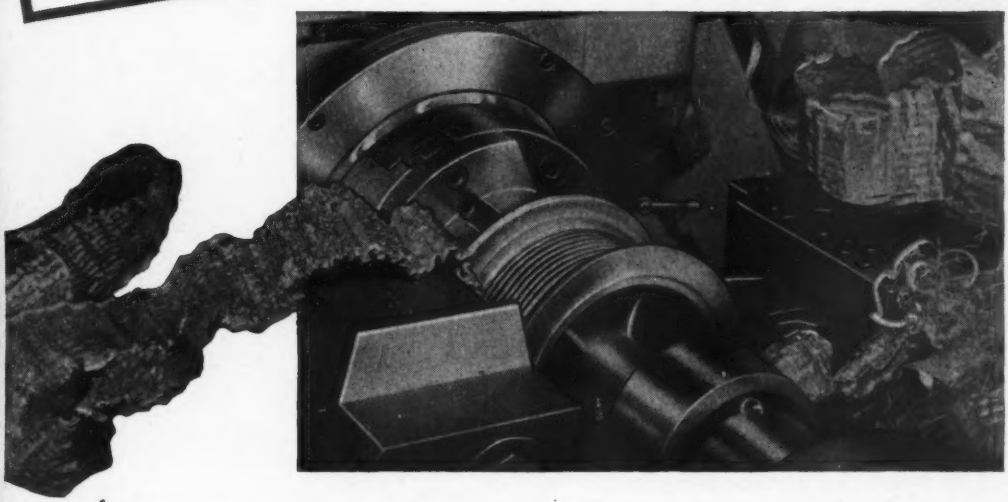
MOTOR CYCLE HUB

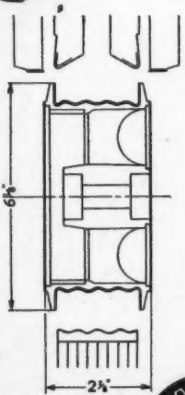
Form O.D. and Face to length

Material: Light Alloy

TIME 24 Secs.

Now *UNRIVALLED* Productive Capacity and Precision — on the *New* FRENCH INNOVATION Multi-Tool Production Lathe





Case hardened prismatic slideways. Scientific geometrical design plus special manufacturing methods ensure undeviating accuracy of all traverses and of the spindle. Headstock even *more* rigid. Servo-electrical feed clutch and braking ensure precise operation of the stops—*and* in the low to medium feed range. New improved composite cast iron and hard steel T-slotted cross-slide carriage designed for heavy section or multiple tooling. Available with automatic cycle, pneumatic or hydraulic chucking and tailstock and numerous items of high production tooling.

	T.7	T.6
Swing over bed	13¾"	17½"
Between centres	21½"	27½"
Spindle revs.	180 to 2,800	45 to 2,000

Send for Brochure M/248 from the Sole U.K. Distributors

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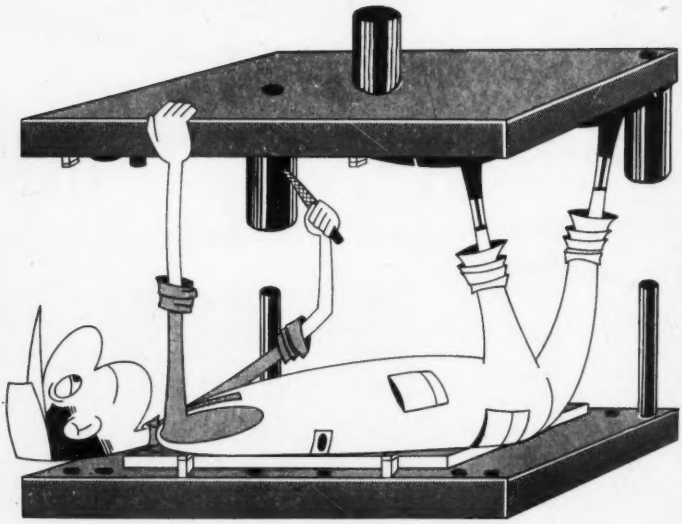
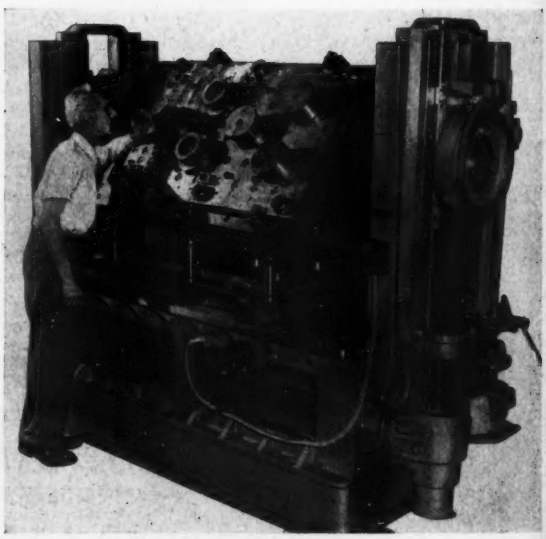
FUNDITOR DIE HANDLER



the modern way to handle dies!

No need to be a freak or a muscle man to handle even the heaviest dies with a Funditor Die Handler. Up to 53 cwt. can be handled with ease by one man. Not only does this eliminate the necessity for you to employ a superman but think of the saving in time on repair, assembly or inspection work. Also consider the safety factor. Eliminating the risk of injury to the operator and damage to expensive dies. It's to *your* advantage to find out more about the Funditor Die Handler. So write for leaflet MT.274



FUNDITOR LIMITED

3 Woodbridge Street, E.C.1.
Telephone: CLErkenwell 6155/7.

6, 1961

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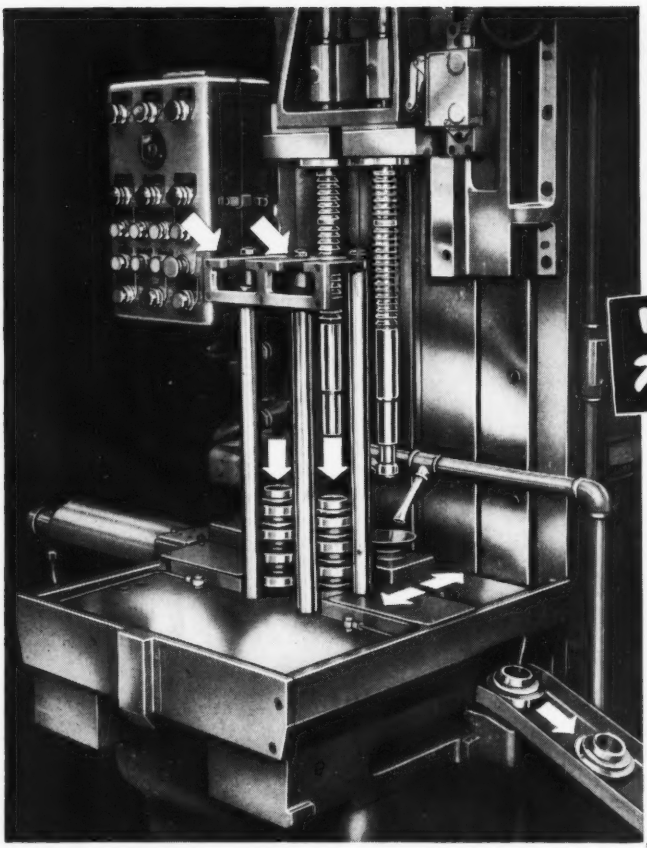

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AUTOMATIC

'American'

BROACHING MACHINES

BUILT & TOOLED

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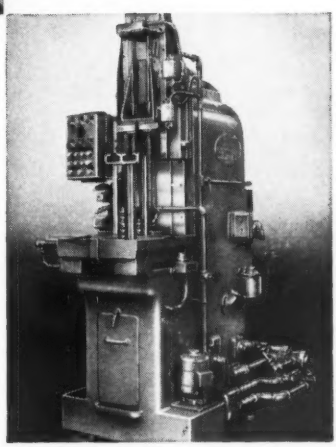
MATRIX

COVENTRY GAUGE & TOOL COMPANY LTD.



The above illustration shows a fully-automatic set-up for internal broaching of gears.

The pre-stacked components are loaded, clamped, broached and ejected automatically.

The tooling is readily converted to accommodate larger or smaller components, and is fool-proofed to guard against accidental damage.

This fully automatic, electrically controlled machine produces 200 components per hour.

Semi-automatic cycle models and untooled machines are available.

When you specify tooled-up British-built 'AMERICAN' Broaching Machines, you can be sure that the Machine, Broaches and Fixture will operate in perfect co-ordination, because they are designed that way with your particular broaching requirements in mind.

ROCKWELL MACHINE TOOL CO. LTD.

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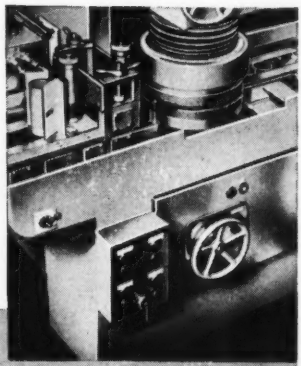
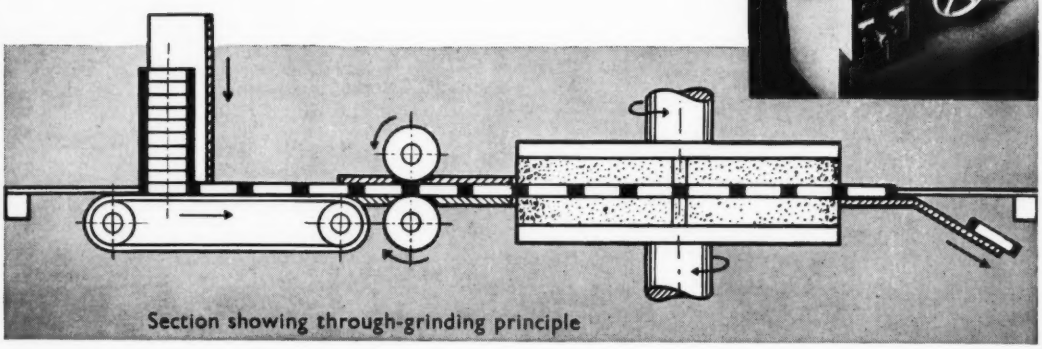
TWIN SPINDLE

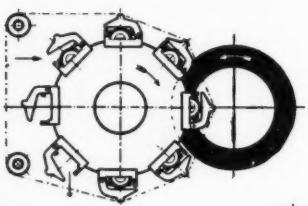
DISKUS

Surface Grinding Machines

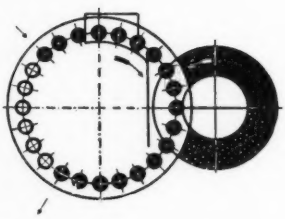




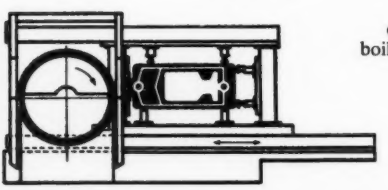
Section showing through-grinding principle



Rotating workholding fixture



Grinding of free workpieces in rotating fixture



Grinding of boiler members

Simultaneous Double-Sided Grinding—With and Without Fixtures

Diskus manufacture a wide range of twin spindle surface grinders for the fast and accurate grinding of workpieces from circlips to large boiler members. If you produce in quantity components with parallel ground faces, please send us details and we will be glad to submit a full quotation for a suitable machine.

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SAG 180 *centre lathe*

- ★ **Bedways hardened and ground**
- ★ **Spindle fitted with gamet bearings**
- ★ **Cam-lock spindle nose**
- ★ **Swings 19½" in gap without removal of gap-block**
- ★ **Hardened and ground gears**

PLEASE SEND FOR FULL DETAILS

Swing over bed	14"
Swing in gap	19½"
Distance between centres ...	40" - 60"
Spindle speeds (9)	45-1,500 or 54-1,800 r.p.m.

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The 'TENNER'

MALE & FEMALE
RADIUS DRESSING FIXTURE

A simple, sturdy, reliable radius dressing fixture, fully protected against dust, and accurate to close commercial limits.

The 'Tenner' has no frills, but can be relied upon to give good service over a long period.

The name 'Habit' is a guarantee of quality irrespective of price.

CAPACITY

TEN/TWENTY
0 — 3in. Female
0 — ¾in. Male
} radii on wheels up to 8in. dia.

TEN/FIFTY
0 — 3in. Female
0 — ¾in. Male
} radii on wheels up to 12in. dia.

OPERATION
By direct motion from handwheel check stops at 90° and 180°.

SETTING
By gauge blocks, height gauge or micrometer.

FITTING
Can be held by magnetic chuck, vice or clamping to bed directly

PRICE
TEN/TWENTY £12
TEN/FIFTY £15
} Ex works London

Postage, container and packing inland 5/-. Suitable diamond Tool 50/-.

A GREAT LITTLE FIXTURE

HABIT DIAMOND TOOLING LTD., LURGAN AVENUE, LONDON, W.6. Telephone: FULHAM 7944

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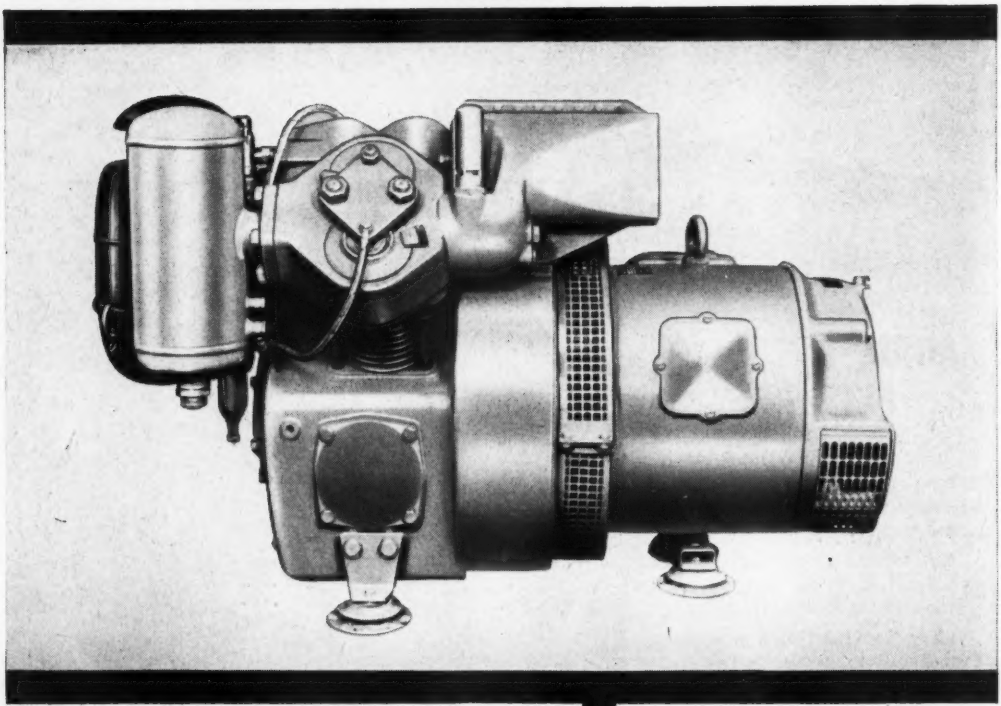
HERE'S AIR POWER FOR THE MEDIUM SIZED WORKSHOP



THE ATLAS COPCO COMPRESSOR TT6

Developed from the famous VT portable compressors, the Atlas Copco TT6 is a compact, heavy-duty machine for round-the-clock operation where there is a moderate but continuous demand for compressed air.

The compressor is a single-acting, two-stage machine with air-cooled cylinders and intercooler. It is built for a normal working pressure of 100 p.s.i. and has a free air delivery of 141 c.f.m.

NO FOUNDATIONS NEEDED. The TT6 and its electric drive motor are mounted on 'Metalastik' bonded rubber feet. This eliminates the need for foundations as the compressor can be placed directly onto concrete floors. The TT6 can also be moved from place to place as circumstances dictate.

Like the VT portables, the TT6 combines an outstanding power/weight ratio with a basically simple design which ensures reliable service and easy maintenance. The TT6 is a sound investment for medium-sized or small-but-growing companies.

AUTOMATIC CONTROL AVAILABLE. Available as an optional extra, the Atlas Copco Regulator allows the TT6 to be run with standard valve unloading system or as a fully automatic stop-and-start unit.

WRITE FOR THE LEAFLET Atlas Copco leaflet E1207-1 gives full details of the TT6. It is freely available on request from the address shown.

ATLAS COPCO (GREAT BRITAIN) LIMITED

Maylands Avenue, Hemel Hempstead, Herts. Tel: Boxmoor 6040

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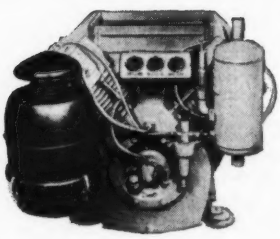

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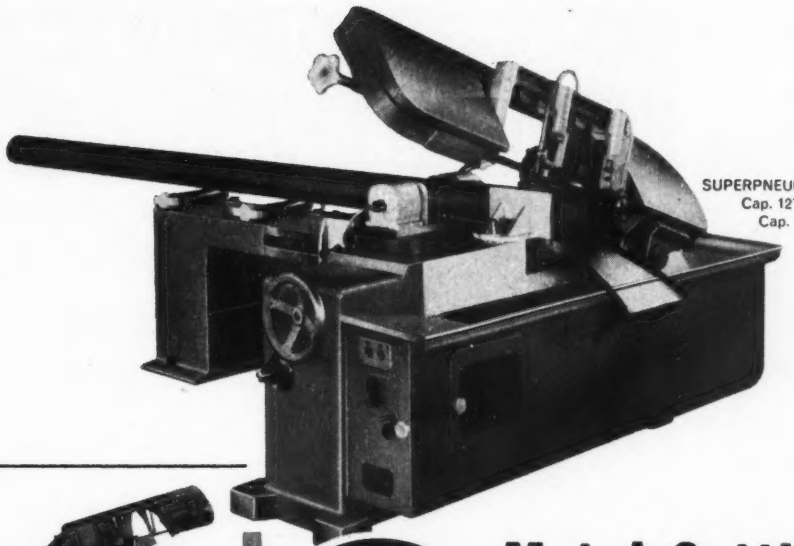
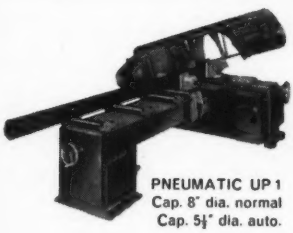
Atlas Copco

puts compressed air to work for the world



SUPERPNEUMATIC UP.2
Cap. 12" dia. normal.
Cap. 10" dia. auto.

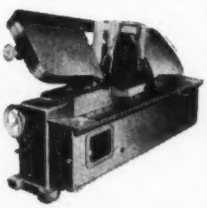


PNEUMATIC UP.1
Cap. 8" dia. normal
Cap. 5½" dia. auto.

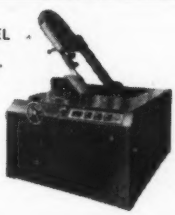
UPAM

Metal Cutting Bandsaws

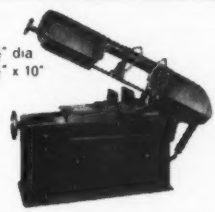
UP.1
Cap. 8" dia.
Cap. 8" x 16"
(Also UP.2
Cap. 12" dia,
24" x 24")



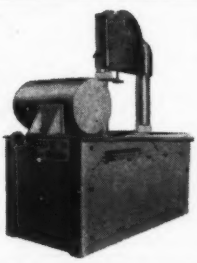
V.500 SWIVEL
Cap. 20" dia.
Cap. 20" x 20"



U.P.O
Cap. 5½" dia
Cap. 5½" x 10"



V.500 FIXED
Cap. 20" dia.
Cap. 20" x 20"
(Also V.600
Cap. 24" dia.
24" x 24")



Built for maximum production from unskilled labour, UPAM Bandsaws offer a model for most needs. Automatic cycles models bring extra savings. All UPAM Machines can be relied on for hard work, precision cuts and continuous service. A leaflet is available.

Built for a Lifetime's Service!

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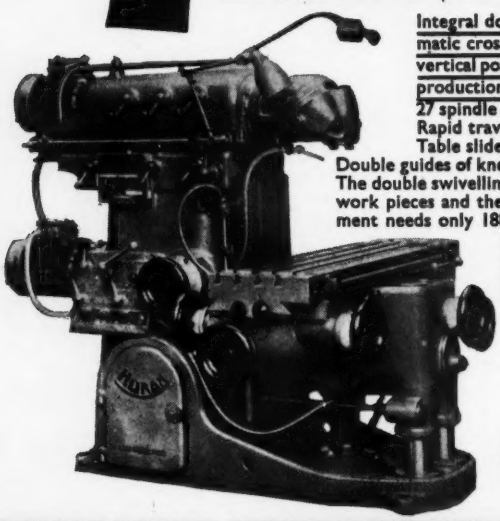
SLIDING RAM GIVES 27½in. AUTO CROSS FEED

HEAVY DUTY MILLING

ANGULAR COMPOUND HORIZONTAL VERTICAL

HURON SUPER UNIVERSAL MILLERS



Integral double swivelling universal head provided with 27½in. automatic cross feed by the sliding ram, can be set to the horizontal or vertical position, or to any angle instantaneously—permits the heaviest production cuts. Heads can be retracted completely from table line. 27 spindle speeds from 30 to 2,066 r.p.m., 27 feeds from $\frac{1}{16}$in. to 30in. Rapid traverses in all directions. All operating controls duplicated. Table slides directly in the knee without cross movement or swivel. Double guides of knee permit components in excess of 1½ tons to be machined. The double swivelling universal head requires an opening of only 14in. to enter work pieces and the whole sliding ram with its 27½in. automatic cross movement needs only 18in. clearance. OPTIONAL EXTRA FEATURES: Mounted spacing casting assemblies providing additional 8in. capacity under spindle. 26in. wide 8 T-slot tables and 39½in. automatic cross feed of sliding ram with special heavy duty knee and front operating position.

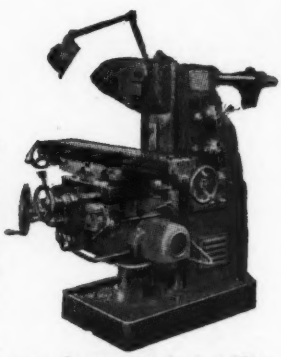
Type	Table	Automatic Feeds Long	Cross	Vert.
KU4	56½in. × 15½in.	43½in.	27½in.	19½in.
KU5	64½in. × 15½in.	51½in.	27½in.	19½in.
KU6	78½in. × 16½in.	59in.	27½in.	19½in.
KU55	64½in. × 26in.	51½in.	38½in.	18½in.
L83	157in. × 59in.	118in.	39½in.	59in.

HURON MU.6/FERRANTI 3-D MILLER

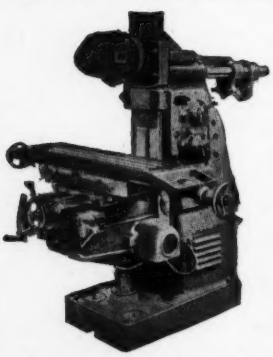
Type 'L' Open-side Traversing Head Universal Miller will mill, bore, slot and drill the largest work-pieces at one setting. The unique design permits greatest variety of operation on large work-pieces; the component remains stationary on the large work-table. Upright slides full length of base table and the sliding ram moves vertically and horizontally.

DUFOUR UNIVERSAL MILLERS

WITH DOUBLE UNIVERSAL SWIVELLING HEAD, RETRACTABLE SLIDE BRACKET AND SPACING CASTING GIVING 26" DAYLIGHT ON No. 59 AND 21" ON No. 61



FOR ALL MODELS Direct reading dial change for speeds and feeds. All parts subject to wear hardened and ground and completely interchangeable. Built to closest tolerances. Rapid traverses in all directions. Table swivels 30°. No. 40 taper for main horizontal spindle, double swivelling universal head, dividing head and rotary table. Hardened and ground centre guide for slideways. Twin overarms. Double swivelling sliding spindle heads with speeds 53-3000 r.p.m. Double swivelling universal head on retractable slide bracket providing with 5½in. Spacing Casting Drive assembly on 59 Machine 26in. daylight, and 21in. on No. 61.



MODELS 53 & 61. 16 universal head spindle speeds. 21-1600 r.p.m.; 8 horizontal spindle speeds 21-1180 r.p.m.; 8 automatic feeds ½-18¾in.

MODEL 59. 36 universal head spindle speeds 14-1780 r.p.m.; 12 horizontal spindle speeds 21-1180 r.p.m.; 16 automatic feeds ½-20in.

MODEL 54. Automatic cross feed of universal head 20in.; 18 universal head spindle speeds 12-1500 r.p.m.; 36 horizontal spindle speeds 6-1500 r.p.m.; 18 automatic feeds $\frac{1}{4}$-23½in.

Type	Table	Automatic Feeds Long.	Cross	Vert.
53	43½in. × 9½in.	27½in.	9½in.	15½in.
61	47½in. × 10½in.	30½in.	9½in.	15½in.
59	51½in. × 11½in.	34½in.	11½in.	21½in.
54	67in. × 14½in.	43½in.	14½in.	20½in.

Send for full particulars of our very extensive range of these machines; ask for demonstration.

Rudolph Carne & Co. Ltd. SWAN WORKS, FISHERS LANE, CHISWICK, LONDON, W.4.

Tel: CHISWICK 0514, 6585 & 0337. Inland Telegrams: RUDCAR, CHISK, LONDON. Overseas Telegrams: RUDCAR, LONDON, W.4.

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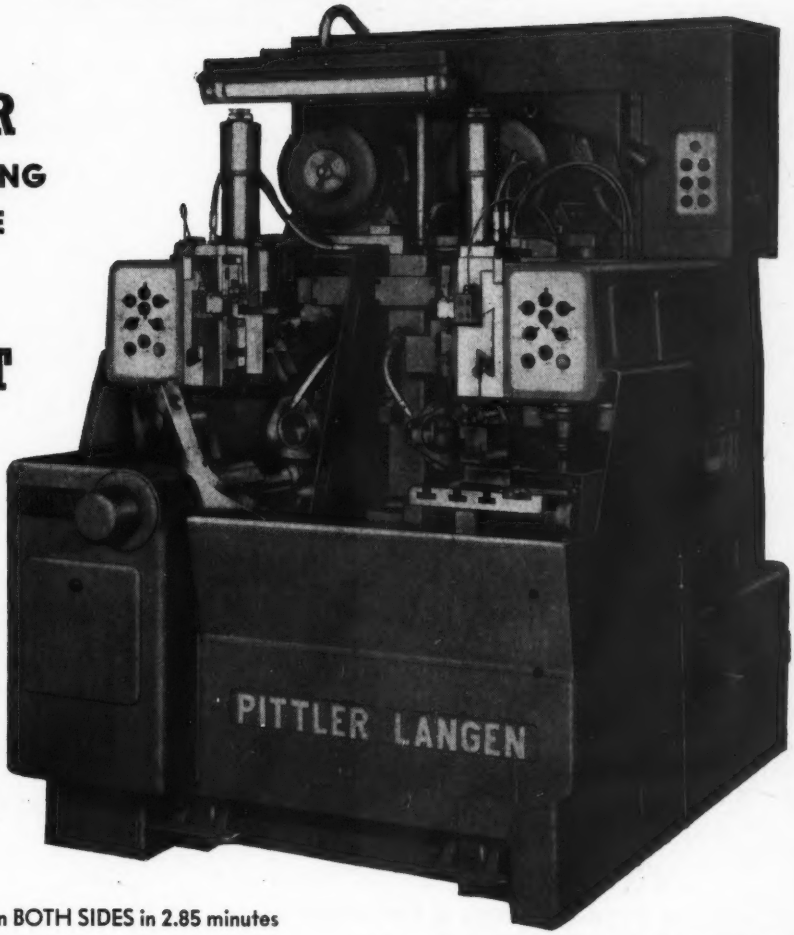
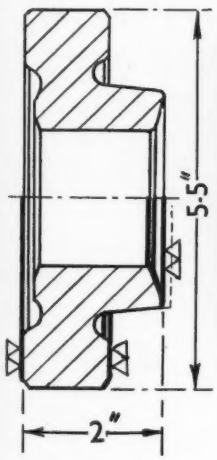
FRONT-LOADING
TWIN-SPINDLE
CHUCKING
AUTOMATIC

PIDOFAT





Gear Blank machined on BOTH SIDES in 2.85 minutes on PITTLER PIDOFAT.

Hydraulic chucking. Turns up to 9" diameter. A fast, powerful and accurate tool to machine both sides of a component simultaneously.

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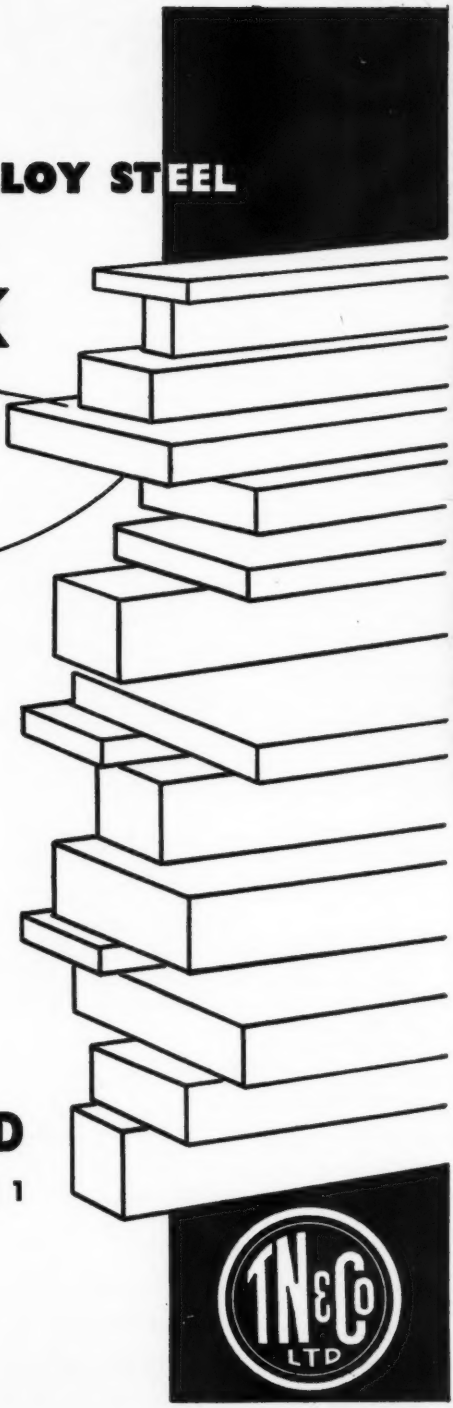

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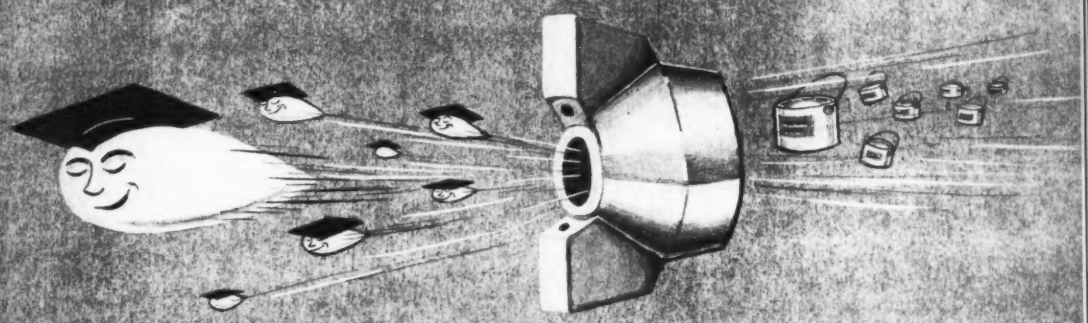

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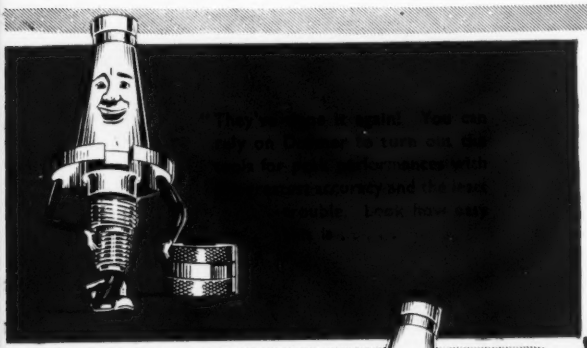
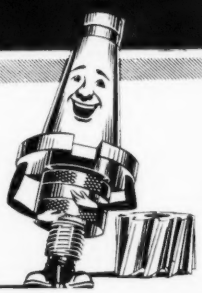
AT ITS SIMPLEST & MOST EFFICIENT



DORMER HELI-MATIC ARBORS AND SCREWED BORE CUTTERS

This high-efficiency combination simplifies screw-locked milling and achieves the greatest productivity.
Ease of assembly, precision in performance, and duration of working life, are the outstanding features of the Heli-Matic equipment.



FIRST STAGE

Screw on the nut by hand —as far as it will go.

TO RELEASE

Apply the spanner to the nut and a few sharp hammer blows will release the nut from the cutter, which can then be screwed off by hand."

You can't go wrong—send for the Heli-Matic brochure giving the full range of Arbors and Cutters.

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for high speed precision stamping

—at rates of up to 600 strokes per minute. The Schuler 4—Pillar Dieing Presses are particularly suitable for carbide tooling and can handle coil or strip material. A Toolmaking Service is available.

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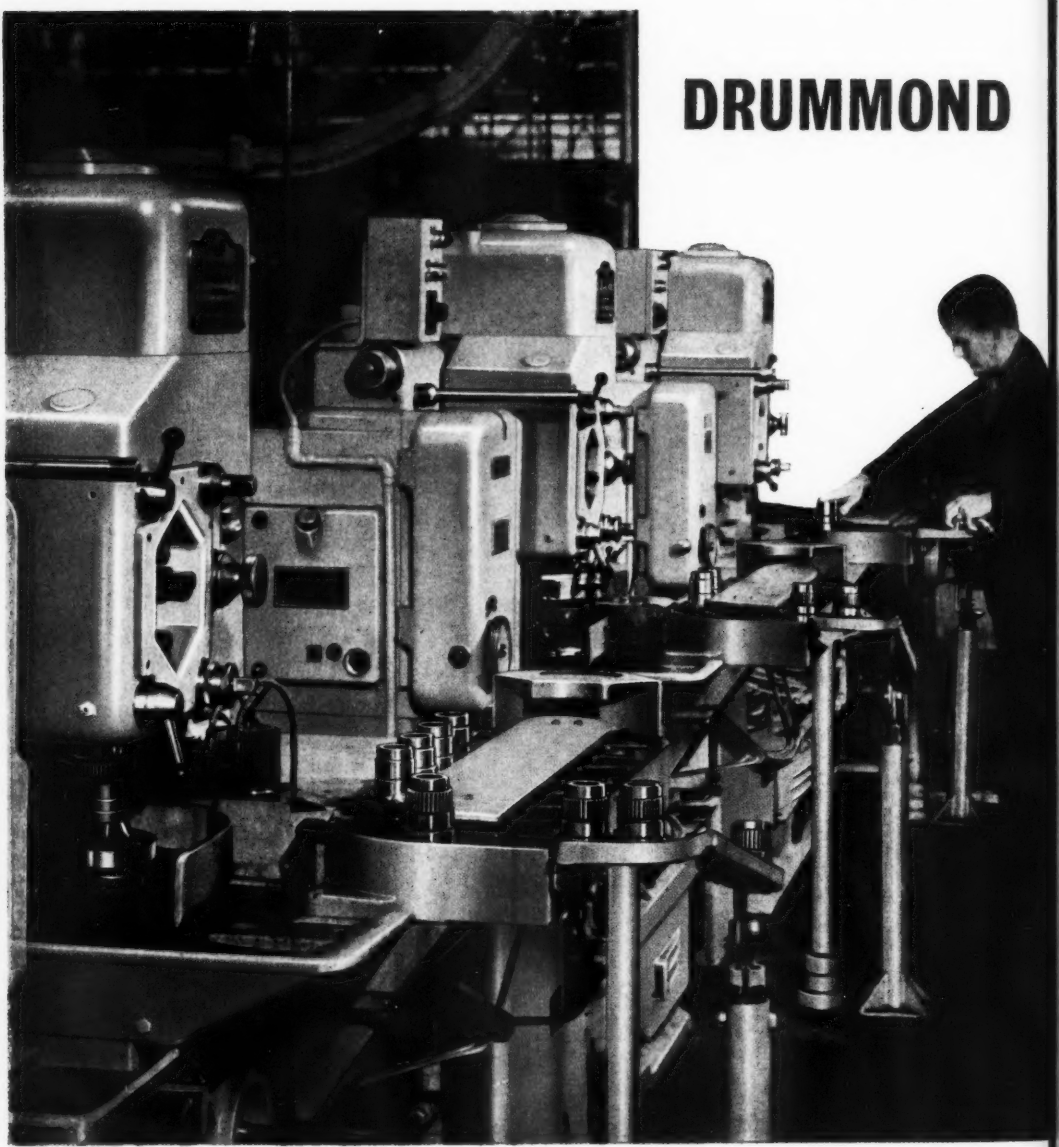
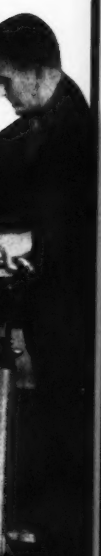


MAXICUT No. 2A GEAR SHAPING MACHINES with swinging arm type automatic loading and unloading equipment, in operation at the Austin Motor Company Ltd., Birmingham.

ND



for HIGHER PRODUCTIVITY

Higher Productivity is important to all manufacturing industries and particularly so to companies concerned with mass production where the benefits to be obtained from installing the most up-to-date machine tools are quickly apparent and the latest developments in automatic handling equipment can be applied to greatest advantage.

Drummond Gear Shaping Machines and Gear Hobbing Machines can be supplied fully engineered for completely automatic production and can be incorporated if required in link lines with Drummond automatic multi-tool lathes to cover all machining from gear blank to finished component.

The No. 2A "Maxicut" Gear Shaper shown on this page is a well-proved machine capable of fast, accurate machining of spur gears up to 7" P.D., helical gears up to 6½" P.D., internal gears, cluster gears and splines, etc.

DRUMMOND BROS. LTD.
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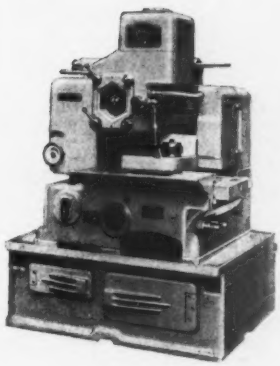
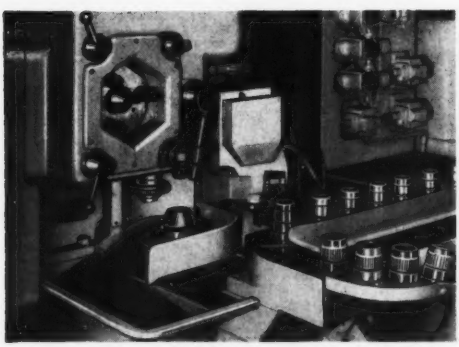
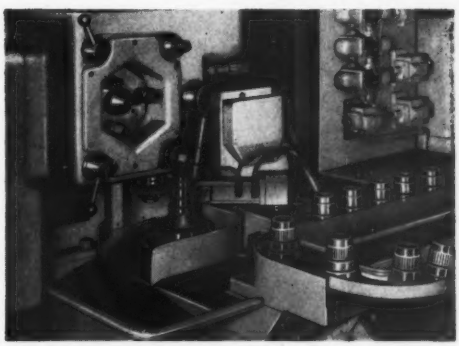


Drummond "Maxicut" No. 2A Gear Shaping Machine is here shown without mechanical handling equipment.



"Maxicut" No. 2A Gear Shaper with swinging arm loader about to pick up a new component.



"Maxicut" No. 2A with the swinging arm in its position after loading the blank.

Sales and Service for the British Isles
DRUMMOND - ASQUITH LIMITED
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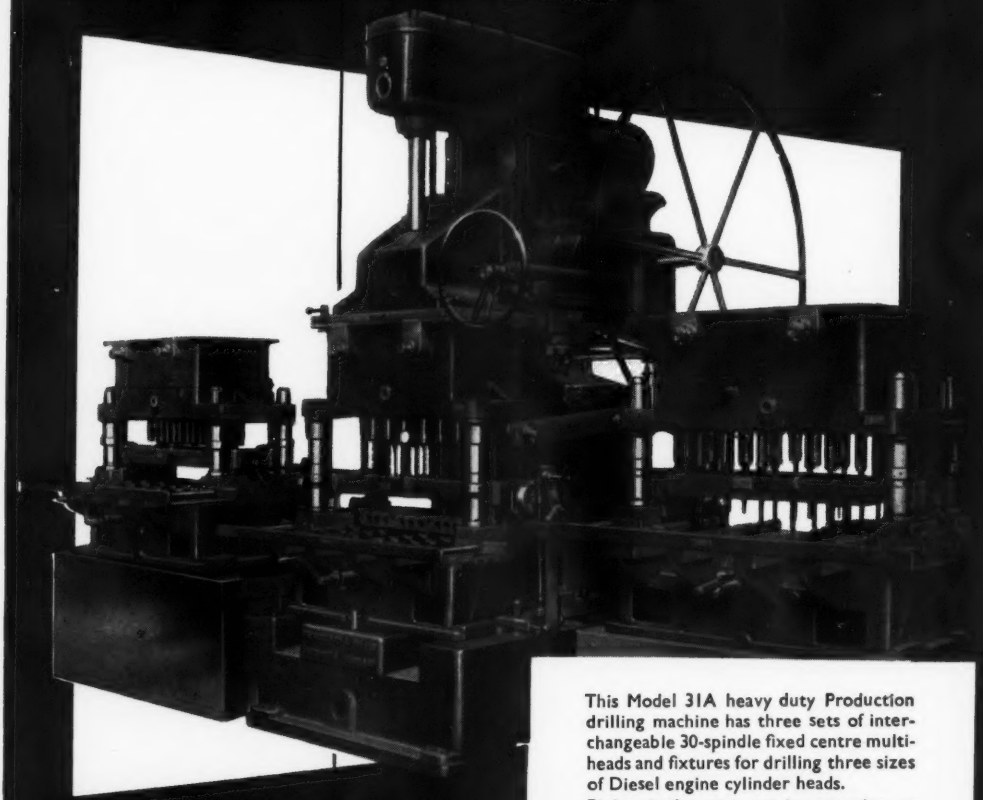
high speed—
heavy duty

PRODUCTION DRILLING

on diesel engine cylinder heads at—F. Perkins Ltd., Peterborough



This Model 31A heavy duty Production drilling machine has three sets of interchangeable 30-spindle fixed centre multi-heads and fixtures for drilling three sizes of Diesel engine cylinder heads.

Eight similar sets are in operation at F. Perkins Ltd., Peterborough. Outstanding amongst the many features of this equipment is great stability, and accuracy of re-location with quick changeovers. Complete changeover in nine minutes.

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LANDIS LUND set-up eliminates separate operations, saving on time, cost and floor space.

Features of this installation include

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Work positioning equipment with illuminated signal control of lateral dimension.

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Models available—10" x 125", 14" x 125", 18" x 125".

- **Hydraulic operation of rapid wheel approach, grinding feed, table engagement and traverse.**
- **Two ranges of stepless, variable work speeds.**
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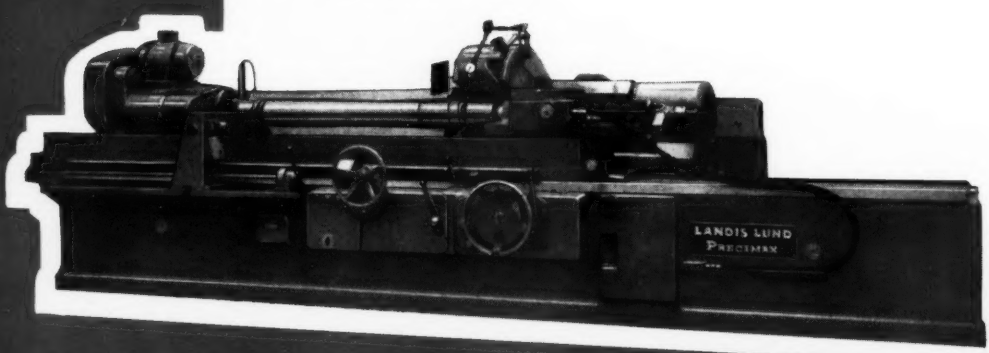
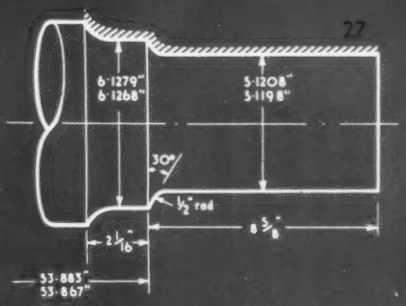


LANDIS LUND 14" x 100" TYPE HMPA CYLINDRICAL GRINDING MACHINE

Cut Costs!



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GRINDING TIME
90 secs. per end

finish grinding railway axles

Grinding twin diameters with blending radii and taper on LANDIS LUND 14" x 100" type HMPA Grinder at 5 minutes per axle, including all handling time.

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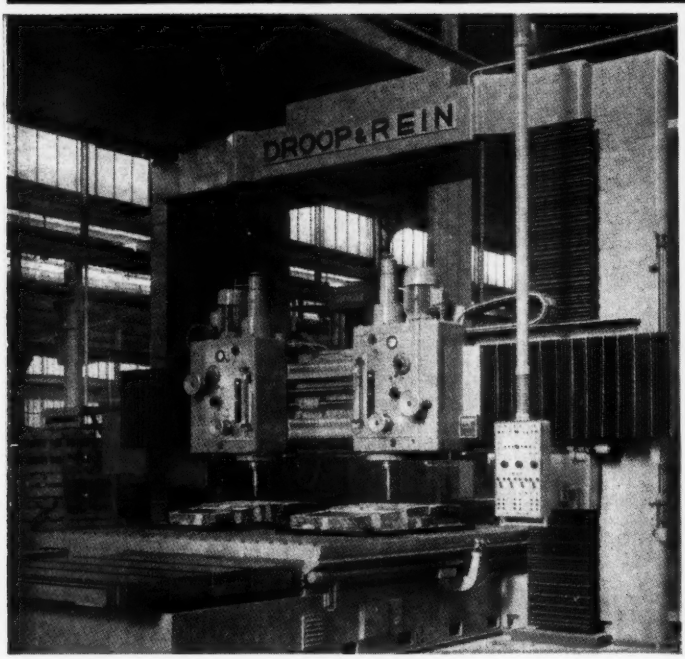
ROTAX BALL SCREWS SPECIFIED BY DROOP & REIN

THE MOST ADVANCED RECIRCULATING BALL THREADS USED IN INDUSTRY



This Droop and Rein double plano-milling machine is probably one of the largest in the world and Rotax ball screws are incorporated to move the cross-rail which weighs over 20 tons. Rotax ball screws meet this demand with an efficiency of over 90% and have great resistance to wear. Made of special stabilised materials they give longer life, greater accuracy and reduce maintenance costs.

Rotax Ball Screws are used wherever a highly efficient transfer of rotary to linear movement, or vice versa, is required. An impressive range of shaft lengths from 2 inches to 25 feet is available with a variety of pitch circle diameters and leads to suit your particular need.

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Harpers will be pleased to send you a booklet which describes their castings in SG iron, grey iron and Harper-Meehanite (the word 'Meehanite' is a registered trade mark). On Lloyd's List for SG iron and Meehanite castings. Metal pressings, machining, enamelling and sub-assembly work are all part of the Harper service.

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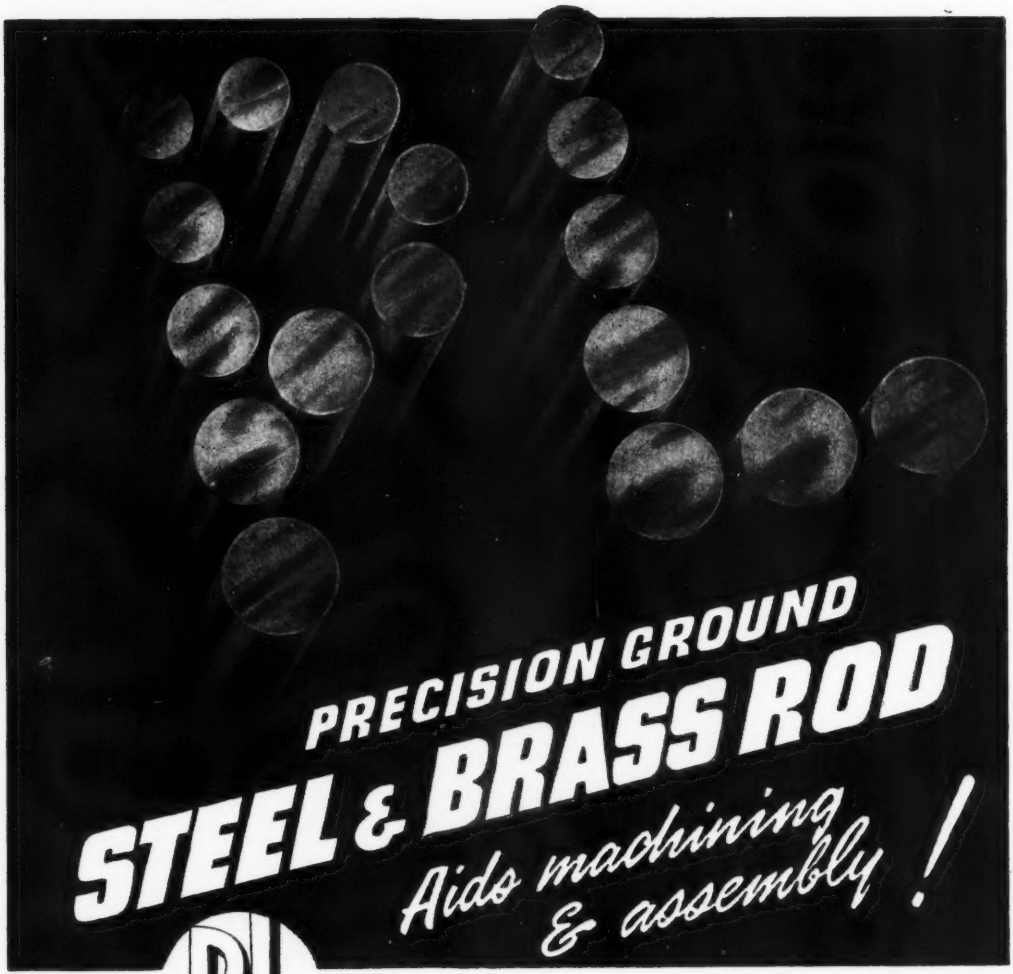

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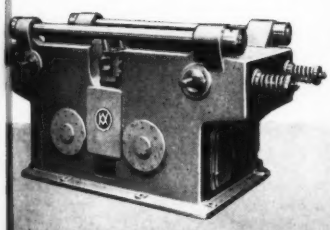
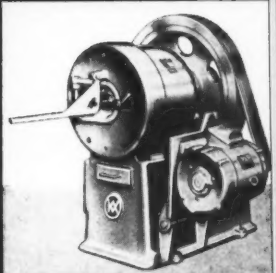
Point Swaging Machines Type ASM for the hot swaging of rectangular sections

High-duty Point Swaging and Reducing Machines Type ASMK for the hot and cold swaging of round sections, particularly for the reduction of drawing tangs on bars and tubes

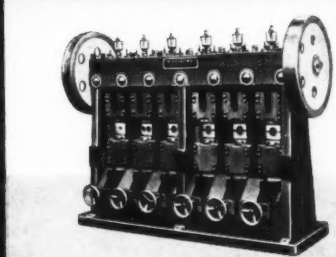
British Agent: **F. W. KUBACH Ltd.**, Wakefield House, 106 Church Road, London, S.E.19.



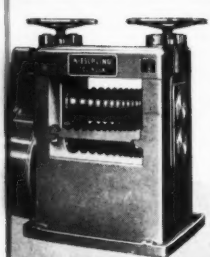
Tube Swaging Machines Type RRK for the cold reduction and sizing of the ends of tubes and bars of low formability, and for forming the inner profiles of tubes over a mandrel



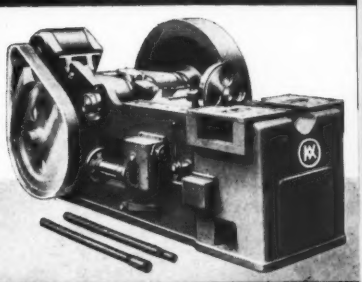
Rapid Hammering Machines Type KRHD in the form of horizontal counter-blow presses with double-sided pairs of side-action tools for the reduction of long tapers by hammering in the hot state, particularly of thick-walled, large-diameter tubes



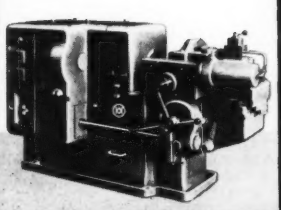
Hammer Swaging Machines for Tubes Type AM in the form of vertical short-stroke multi-stage presses using a number of tools which are actuated vertically from above by individual rams, for the reduction of gripping tangs on tubes in the cold state and for the hot forging of small ironware



Reducing Rolls Type SAWN for reducing the ends of tubes and bars and forming the drawing tangs by means of multi-pass rolls, in the hot or cold state



Tube Expanding and Reducing Machines Type REM in the form of horizontal rotary presses for expanding or reducing tube ends in the cold state, e.g. for boilermaking purposes. These machines can also be supplied with automatic tube feeding and removal equipment as the Type REMS



Tang Milling Machines Type SAM for the metal-removing forming of drawing tangs on large-diameter bars

TH. KIESERLING & ALBRECHT
WERKZEUGMASCHINENFABRIK · SOLINGEN
GERMANY

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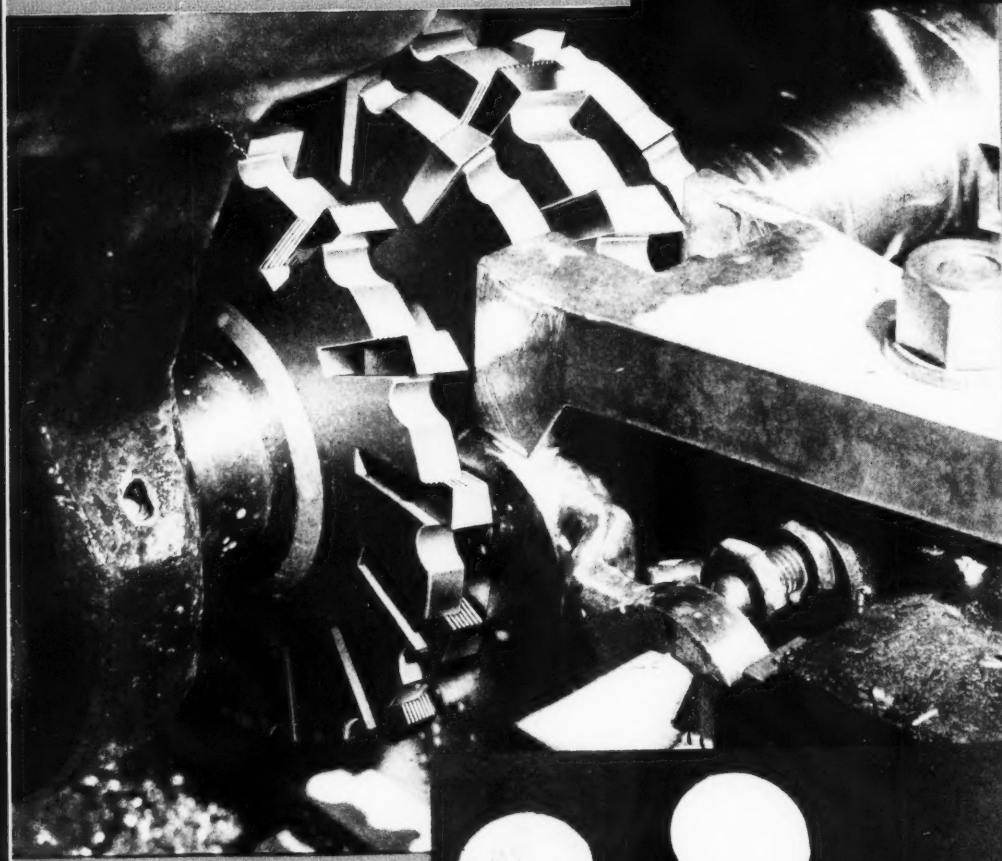
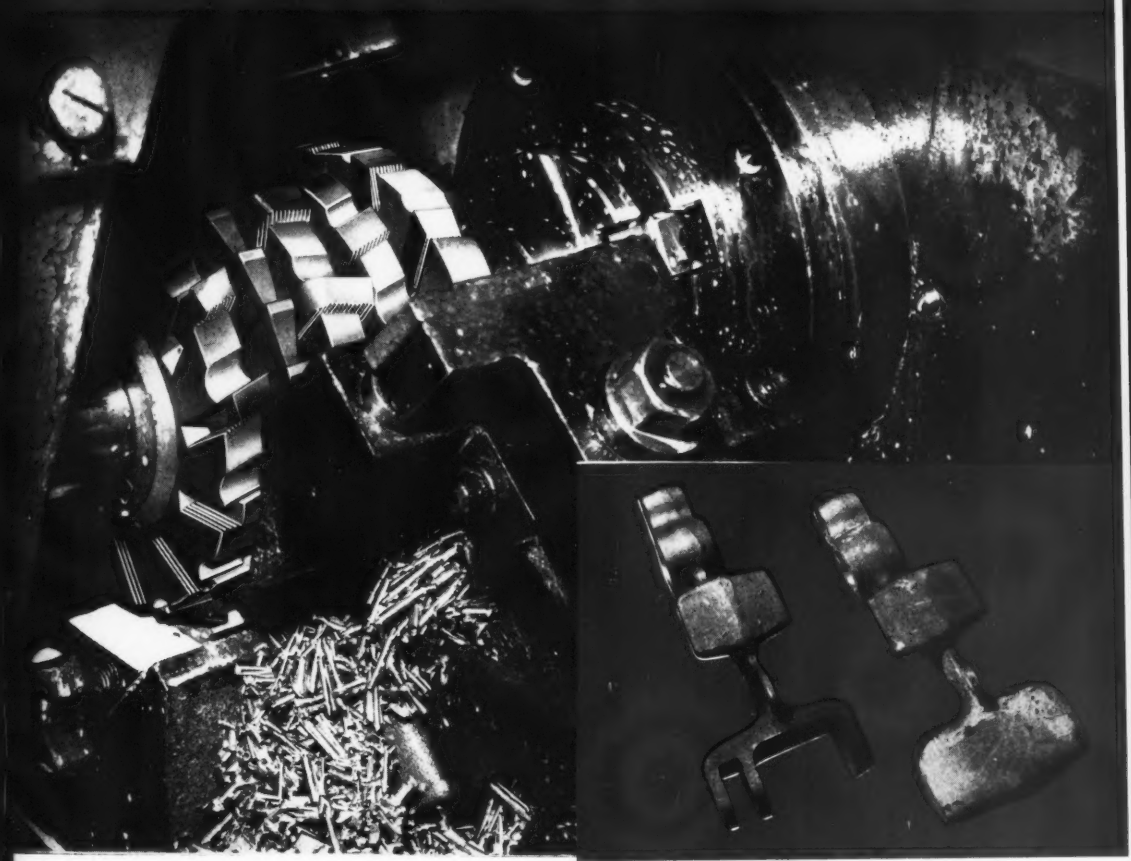
TRADE MARK



Front engine shackles are set-up in pairs and straddle milled to width as shown.

SERRATED BLADE CUTTERS



Above we show the milling from solid of brake levers using a gang of four cutters.

Leyland Motors Ltd., Leyland, Lancs., rely on GALTONA serrated blade cutters for a wide range of operations where maximum production, combined with long life between the grinds is important.

Our Tool Engineers will be happy to co-operate with you on your own production problems and we invite you to get in touch with us.

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GALTON HOUSE, ELMFIELD AVENUE, TYBURN, BIRMINGHAM, 24

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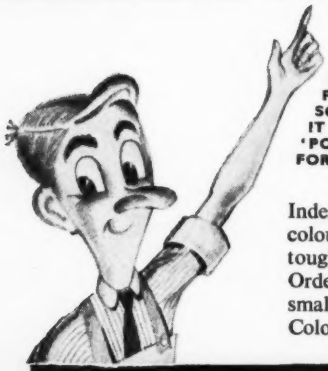
SQUARE D ALL METAL PUSHBUTTONS



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Indestructible operator is made entirely of metal. High-density polyethylene colour caps are permanently coloured, won't fade or deteriorate on even the toughest jobs. Pushbuttons are completely oil-tight even when depressed. Order pushbutton in the colour you want or get the basic operator and with a small stock of colour caps, decide your colour at the point of application. Colour caps just " Pop-on "—may be changed in seconds if necessary—design leadership AT NO EXTRA COST. Seven colours available. Choose from black, red, green, brown, yellow, orange, blue.

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IMPROVED MODELS IN THE MARBAIX RANGE OF DISINTEGRATORS

MODEL M.61-CS
Completely self-contained with Servo feed, requiring NO ATTENTION FROM OPERATOR whilst cutting is in progress.

MODEL M.61-C
Self-contained model with universal head fixture and adjustable cross-arm.

MODEL M.61
Similar to Model M.61-C but without head fixture and cross-arm.

MODEL M.60
Bench Model, primarily intended for the removal of broken tools.

Any of the above models will

* **REMOVE BROKEN TOOLS FROM COMPONENTS RAPIDLY, CLEANLY AND WITHOUT DAMAGING COMPONENT.**
* Cut holes at any angle and of any shape in hardened materials.

MARBAIX INDUSTRIES LTD.
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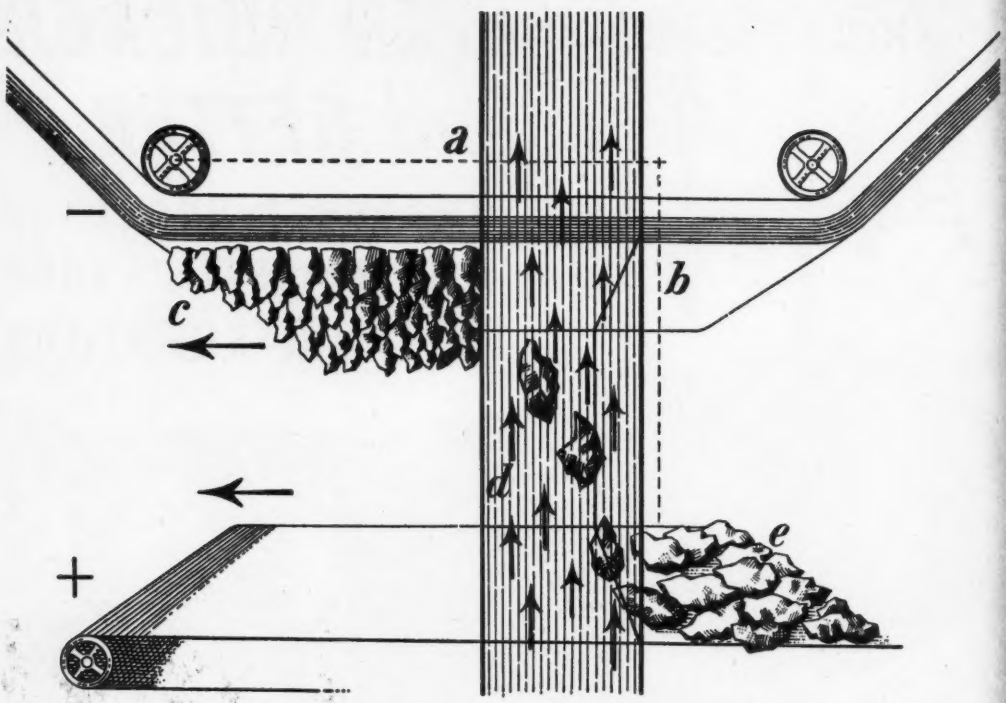

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Every razor-edged grain in EAC abrasives stands bolt upright, presenting maximum cutting power to the work in hand. The grit, orientated on its longitudinal axis, is shot arrow-like into the adhesive by electrostatic force. That's why EAC abrasives literally bristle with cutting edges, work faster and last longer than ordinary makes. There's the right EAC abrasive for every operation. Insist on EAC for the best of good reasons—it saves money!

"BRITANNIA" EAC ENGLISH ABRASIVES CORPORATION LTD "JOHN BULL"

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ENGLISH ABRASIVES CORPORATION LIMITED

Marsh Lane, Tottenham, London, N.17. Telephone: Tottenham 5057

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1961

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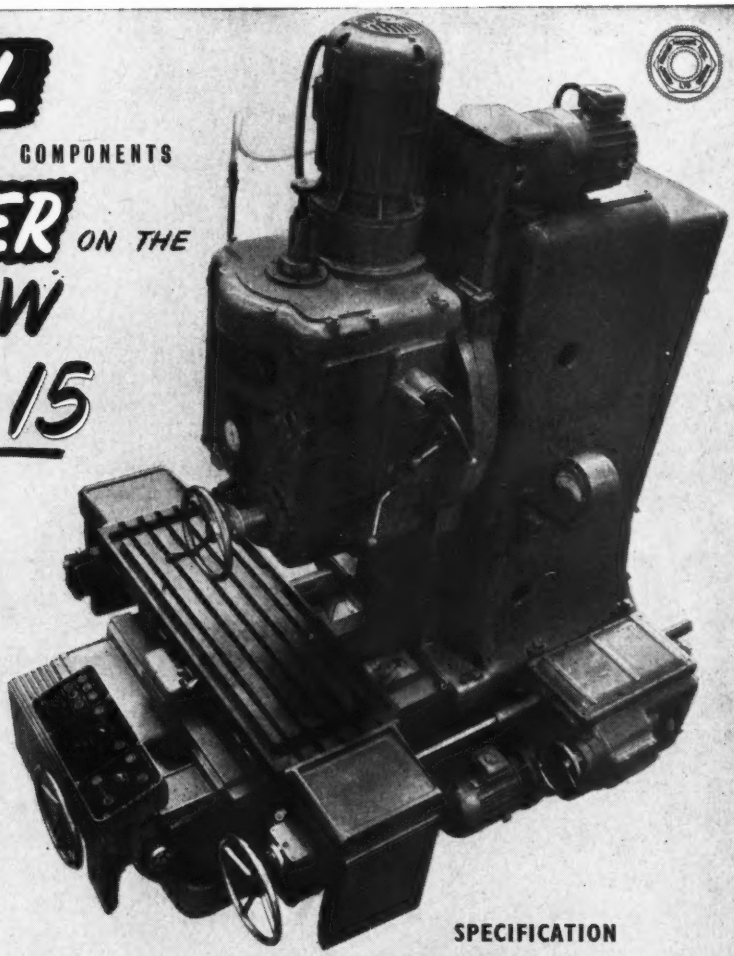
MILL

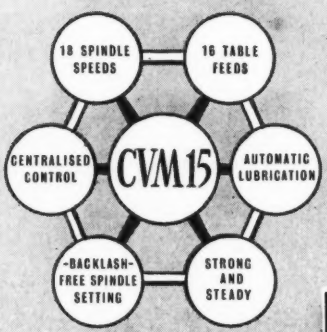
THOSE SMALLER COMPONENTS

FASTER ON THE NEW CVM 15



OPTIONAL EXTRAS

- SWIVEL MILLING HEAD
- POWER TRAVERSE TO SPINDLE
- BORING FEEDS TO SPINDLE
- RETRACTION OF SPINDLE
- INFINITELY VARIABLE FEEDS
- CYCLE MILLING
- TWO-DIMENSIONAL PROFILING
- AUXILIARY CIRCULAR TABLES
- SIDE MILLING MANDREL AND SUPPORT
- DIAL GAUGES FOR BORING



SPECIFICATION

WORKING SURFACE OF TABLE	54 in. x 16 in.
HEIGHT ADMITTED BETWEEN SPINDLE NOSE & TABLE	MIN. 1½ in. MAX. 24 in.
DISTANCE FROM CENTRE OF SPINDLE TO FACE OF COLUMN	18 in.
SPINDLE ADJUSTMENT	6 in.
SPINDLE DRIVING MOTOR	10 h.p.
SPINDLE SPEEDS: up to 1600 r.p.m.	
THREE OPTIONAL RANGES OF 18 SPEEDS	
RANGE 1.	20 TO 1000 r.p.m.
RANGE 2.	25 TO 1250 r.p.m.
RANGE 3.	32 TO 1600 r.p.m.
TABLE FEEDS: up to	63 ins./min.
FOUR OPTIONAL RANGES OF 16 FEEDS	
RANGE 1.	0·8 TO 25 ins./min.
RANGE 2.	1·18 TO 37·5 ins./min.
RANGE 3.	1·6 TO 50 ins./min.
RANGE 4.	2 TO 63 ins./min.
TABLE RAPID TRAVERSE	100 ins./min.

FOR FULL DETAILS WRITE TO

KENDALL & GENT Ltd.

Phone EAST 3282 GORTON MANCHESTER

K249

C2

THE wm RANGE

The range of machines produced by Woodhouse & Mitchell includes centre lathes and turret millers. Three of the latest designs are illustrated here : built to modern specifications, they are being used with complete satisfaction by discriminating engineers.

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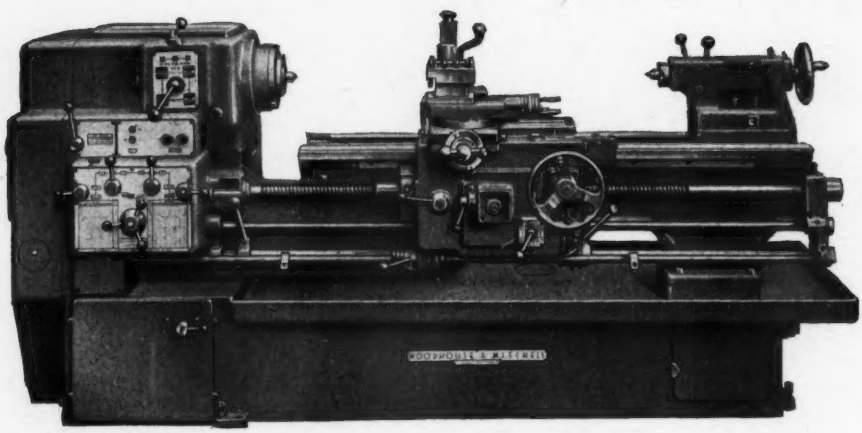


'85' 8½" and 10½" Centre Lathes

8½in. size : 10 h.p. motor, 12 speeds 21-945 r.p.m.

10½in. size : 12 speeds 14-630 r.p.m.

alternative, 21-945 r.p.m.

WOODHOUSE & MITCHELL

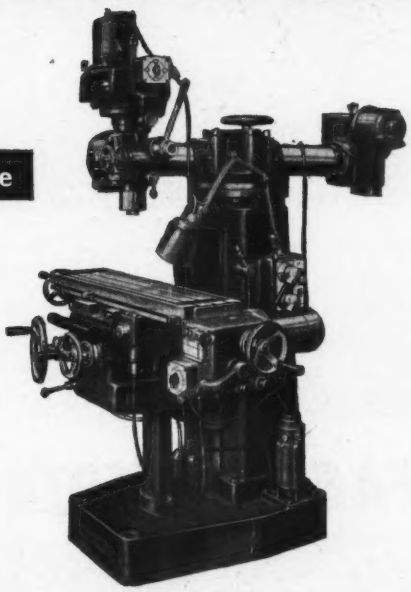
When answering advertisements kindly mention MACHINERY.

'70' Junior 7" Centre Lathe

2 h.p. motor; 8 speeds, 30-437 r.p.m. also alternative 44-640 r.p.m., and (when fitted 2-speed motor) 30-874 r.p.m. and alternatively 40-1200 r.p.m. Sizes are made to admit 45in., 54in. and 72in. between centres.

wm wm wm wm

369 Turret Milling Machine



For millling, boring and jig-boring at any angle, key-way and end milling, die-sinking, mould and pattern-making. Table 36in. by 9in., 10 spindle speeds 100-2000 r.p.m. (alternative 200-4000 r.p.m.)

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PHONE: BRIGHOUSE 627 (3 LINES) — GRAMS: 'WOODHOUSE BRIGHOUSE'

WM33

Weekends
it's important to this
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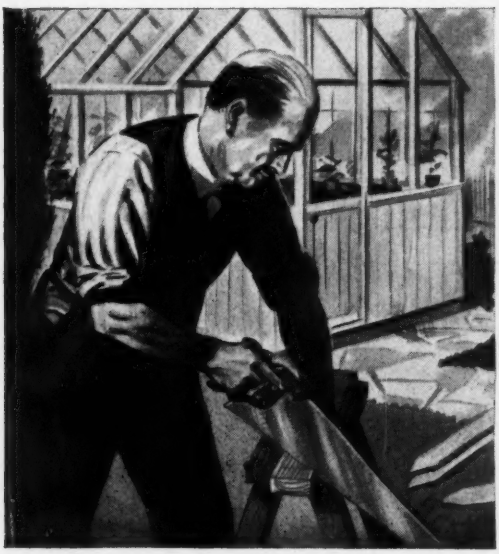
that he has the best
tools he can buy—
Spear & Jackson of course!

Weekdays
it's important to him as a
production engineer to use
the best tool steel for the
job—to him, that means
Spear and Jackson again!



Spear & Jackson not only make superb woodworking and garden tools — they make a range of tool steels too! With a background of 200 years of making steel for fine saws, it's not surprising that these tool steels should rate so high in their classes. If you're looking for consistent quality in tool steel, specify Spear steels—you won't be disappointed! Data sheets available on request.

SPEAR & JACKSON *TOOL STEELS TO TRUST*

Other products include: *Segmental Saws · Hot Saws · Friction Saws Hacksaws · Metal Cutting Bandsaws · Fusion Bands · Tungsten Carbide Tipped Saws and Cutters · Machine Knives · Ground Flat Stock*

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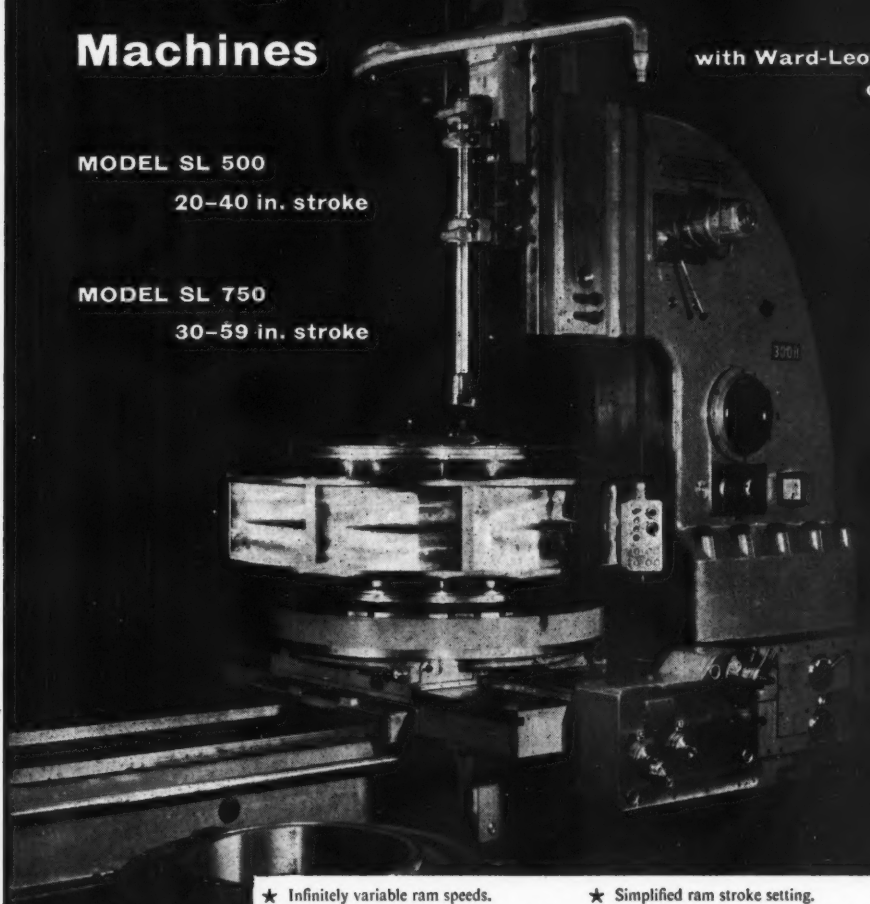
Slotting Machines

with Ward-Leonard drive

MODEL SL 500
20–40 in. stroke

MODEL SL 750
30–59 in. stroke



★ Infinitely variable ram speeds.
★ Variable, independent, ram return speed.
★ Universal, built-in dividing mechanism.
★ Inclinable (12°) ram slide.
★ Simplified ram stroke setting.
★ Convenient operation and simple tool changing.
★ Optional equipment for internal or external spiral grooves.

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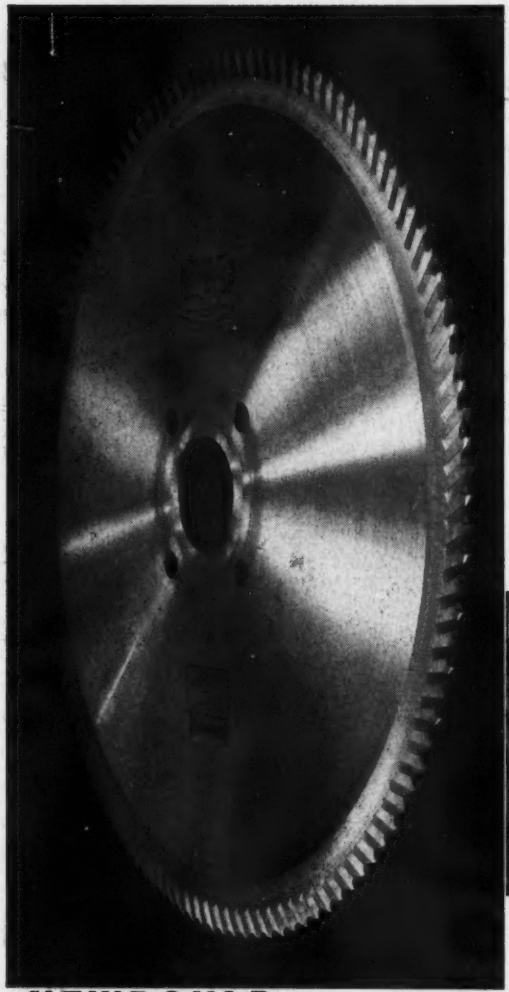

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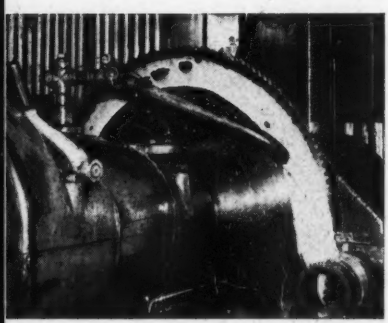

The NEWBOULD segmental saw

The scientific tooth design of the NEWBOULD segmental saw enables ferrous and non-ferrous metals to be cut at maximum feeds and speeds. Alternate roughing and finishing teeth produce free-curling, easily-cleared chips, reducing friction, minimising power wastage.
Made in sizes from 11" to 60" diameter with tooth segments of SABEN EXTRA high speed steel for maximum life between re-grinds.

Details on application.

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This aluminium component is

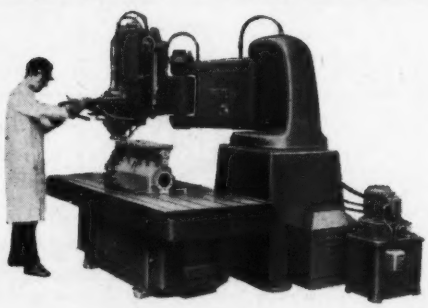
face-milled in 130 seconds !

Wadkin Articulated Arm Router L.C. face-milling the weighing machine component shown above.

HERE is a typical example of the amazing time and cost cutting advantages of machining light alloys on a Wadkin Articulated Arm Router, L.C. This router face-mills the weighing machine component, shown above, in a fraction of the time taken by any other method and yet its initial cost is relatively low. Three models are available: heavy duty type L.C. with either 6′ 0″ reach (illustrated) or 8′ 0″ reach, and the medium capacity machine, type L.C.6 with canting table.
Full details of these machines are given in Leaflet No. 945, available on request.

Wadkin

HIGH SPEED MACHINE TOOLS



Wadkin Articulated Arm Router L.C. face-milling an engine crank-case.

Wadkin Ltd., Green Lane Works, Leicester. Tel: 68151. London Office: 62-64 Brook St., W.1. Tel: MAYfair 7048

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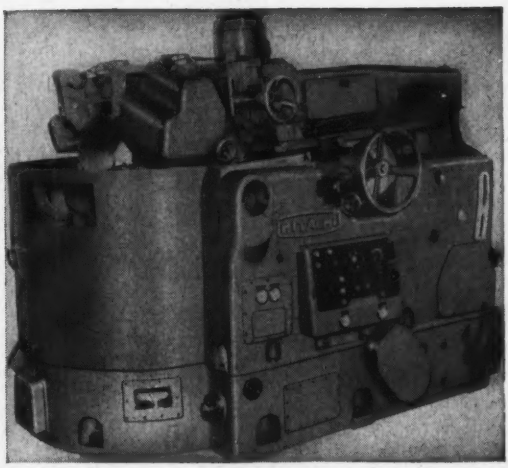
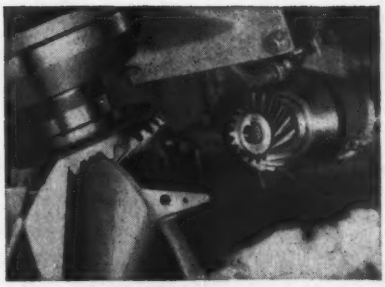
Efficiency *plus*
HITACHI
Bevel Gear Grinder



HITACHI Bevel Gear Grinder Type 600 BG-1



WORK HEAD
The photo shows that a set of gear and pinion is fitted on each work head.

DIAL FOR AUTOMATIC SETTING
The table constructed in the two-stage type, and is provided with a screw for parallel slide and a dial.

Characteristics:

The HITACHI bevel gear grinder, Type 600 BG-1, has been designed on an entirely new principle of generating method, and is credited with the following features:—

1. **The machine can be operated with utmost ease.**
2. **Crowning is possible even in the direction of gear teeth.**
3. **The same grinding wheel can be used irrespective of dimensions, helix angles, pressure angles of the bevel gears to be processed.**
4. **Meshing tests can be conducted without removing the processed gear.**

Specifications:

Max. pitch dia.	**610 mm.**
Min. pitch dia.	**50 mm.**
Largest cone distance	**305 mm.**
Pressure angle	**14½°—20°**
Max. helix angle	**35°**
Module	**2.5M—8M**
Dia. of grinding wheel	**400 mm.**
Main Motor	**5 h.p.**
Size of Machine	**2,765 mm. x 2,000 mm. x 1,850 mm.**
Net Weight	**approx. 11,00 kg.**

Patents on this grinder:—

Patents have been applied for in the United States, Britain, Germany, Switzerland and Italy, in addition to those already taken out in Japan.

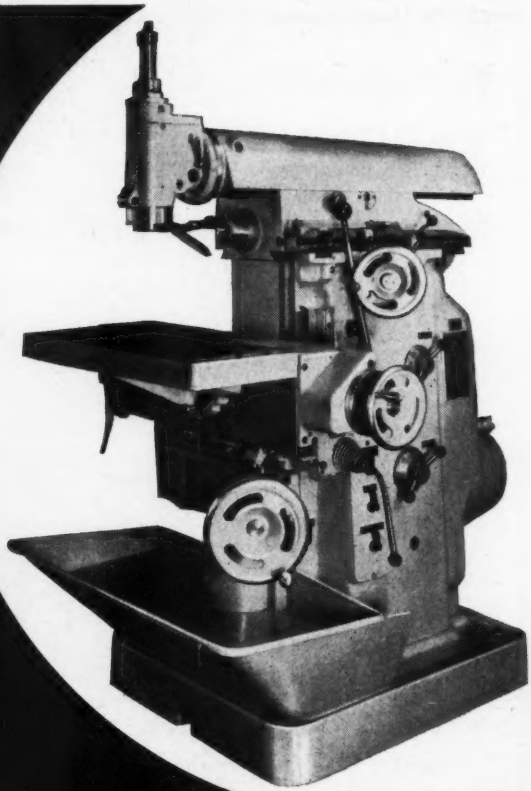
Other HITACHI products include:—

Gear hobbing machines
Knee-type milling machines
Surface grinders
Roll lathes and grinders
Railway car wheel lathes
Axle journal returning and burnishing lathes
Transfer machines, etc.

Hitachi, Ltd.
Tokyo Japan
Cable Address: "HITACHI" TOKYO

RUHLA

UNIVERSAL DIE-SINKING & TOOL MILLING MACHINES



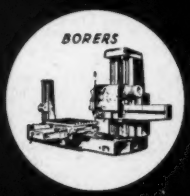


Table	Model 58	Model 59
Working surface	10¼" x 28¾"	12⅝" x 32¾"
Longitudinal traverse	12"	14"
Vertical movement (Power or hand)	12"	14"
Ram movement (Power or hand)	10"	12½"

	Model 58	Model 59
Spindle speeds		
Vertical spindle	102—1,250 r.p.m.	80—1,840 r.p.m.
Horizontal spindle	67—825 r.p.m.	52—1,200 r.p.m.
H.P.	2	4
Taper	30 INT.	40 INT.

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WILLIAM WATTS LIMITED

CANAL STREET NOTTINGHAM TELEPHONE NOTTINGHAM 55502

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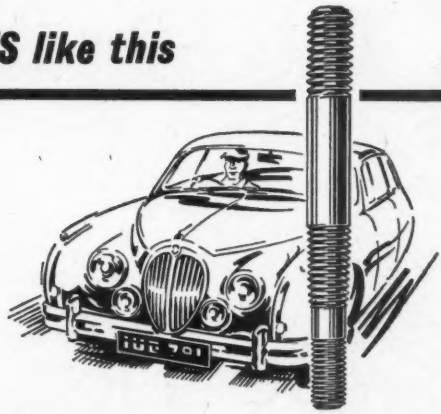
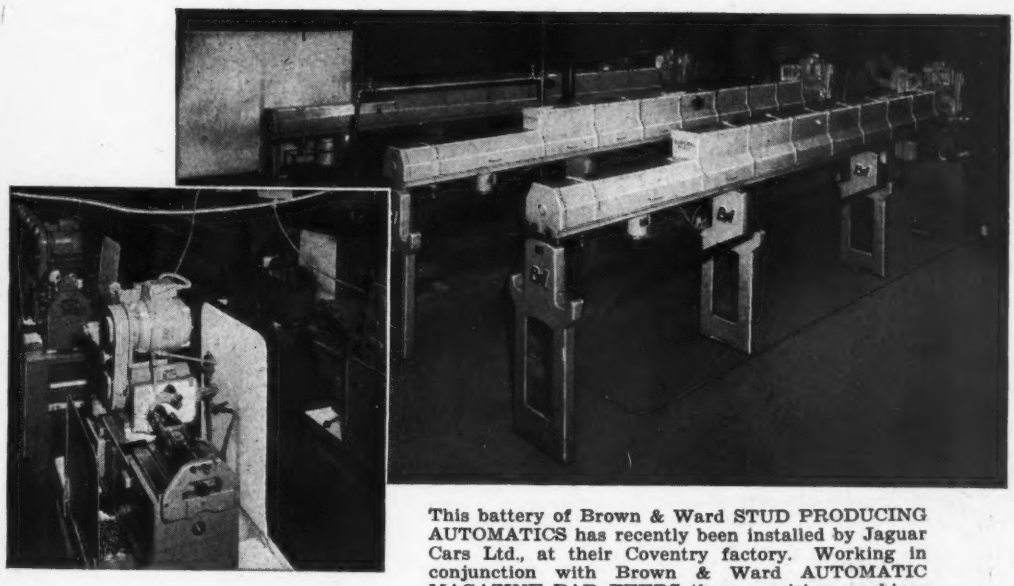


JAGUAR cars choose BROWN & WARD



This battery of Brown & Ward STUD PRODUCING AUTOMATICS has recently been installed by Jaguar Cars Ltd., at their Coventry factory. Working in conjunction with Brown & Ward AUTOMATIC MAGAZINE BAR FEEDS these precision machines are producing components, like the threaded stud shown above, at maximum output and to the exacting standards required by Jaguars. The simplicity of these machines and equipment ensures reliability, and consequently a high productive efficiency, a fact which has been proved by the large numbers of machines installed in this and many other countries throughout the world.

Selling Agents in the U.K.: ALFRED HERBERT LTD., COVENTRY.

Automatic Bar Machines and Magazine Bar Feeders

BROWN & WARD (TOOLS) LTD.

Leamore Lane, Walsall. Telephone Bloxwich 76846

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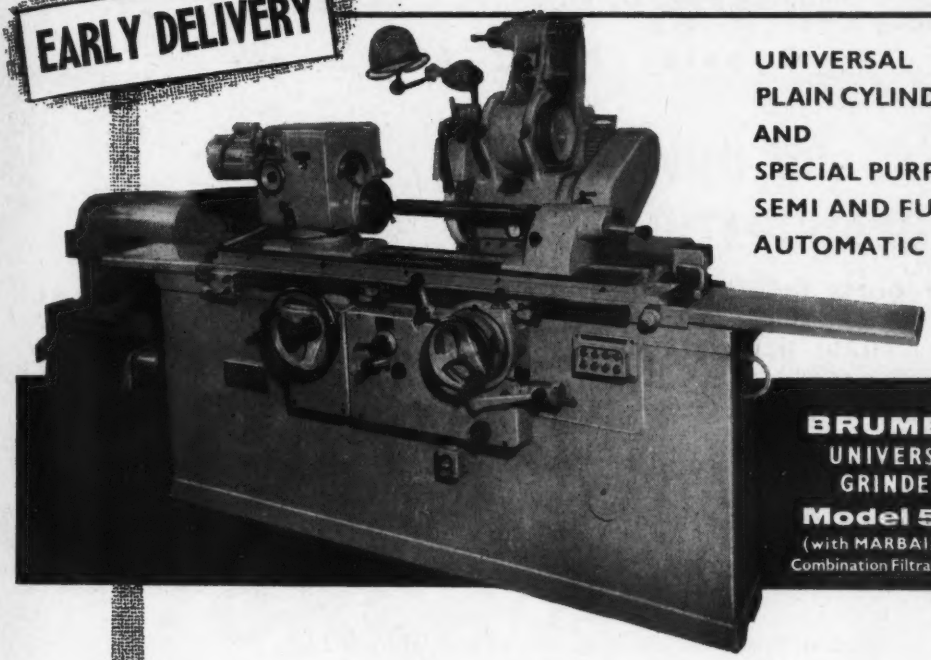
BRUMECA *High Precision* GRINDING MACHINES

EARLY DELIVERY



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PLAIN CYLINDRICAL
AND
SPECIAL PURPOSE
SEMI AND FULLY
AUTOMATIC

BRUMECA
UNIVERSAL
GRINDER
Model 5010
(with MARBAIX MP10
Combination Filtration Unit)

- Modern machines built in a modern factory.
- Dual hydraulic system with separate pumps — easily accessible for maintenance.
- Rapid advance and retraction of wheelhead.
- Automatic feed for plunge cut grinding.
- Hinged internal grinding attachment.
- Accurate adjustment for shoulder grinding.
- 4 H.P. Wheelhead motor as standard — specials to suit.

10¼" swing 29½" centres

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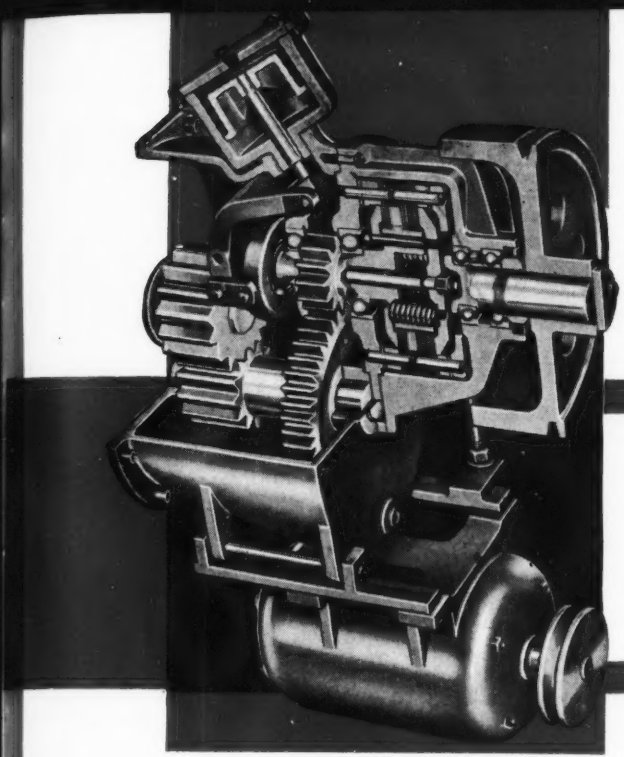

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MOTOR, FLYWHEEL AND TORC-PAC DRIVE ENTIRELY WITHIN PRESS FRAME	CENTRALISED OIL LUBRICATION
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WELDED STEEL FRAMES GIVE BIG VARIETY OF SIZES	INCLINING ADJUSTMENT BY SINGLE SCREW
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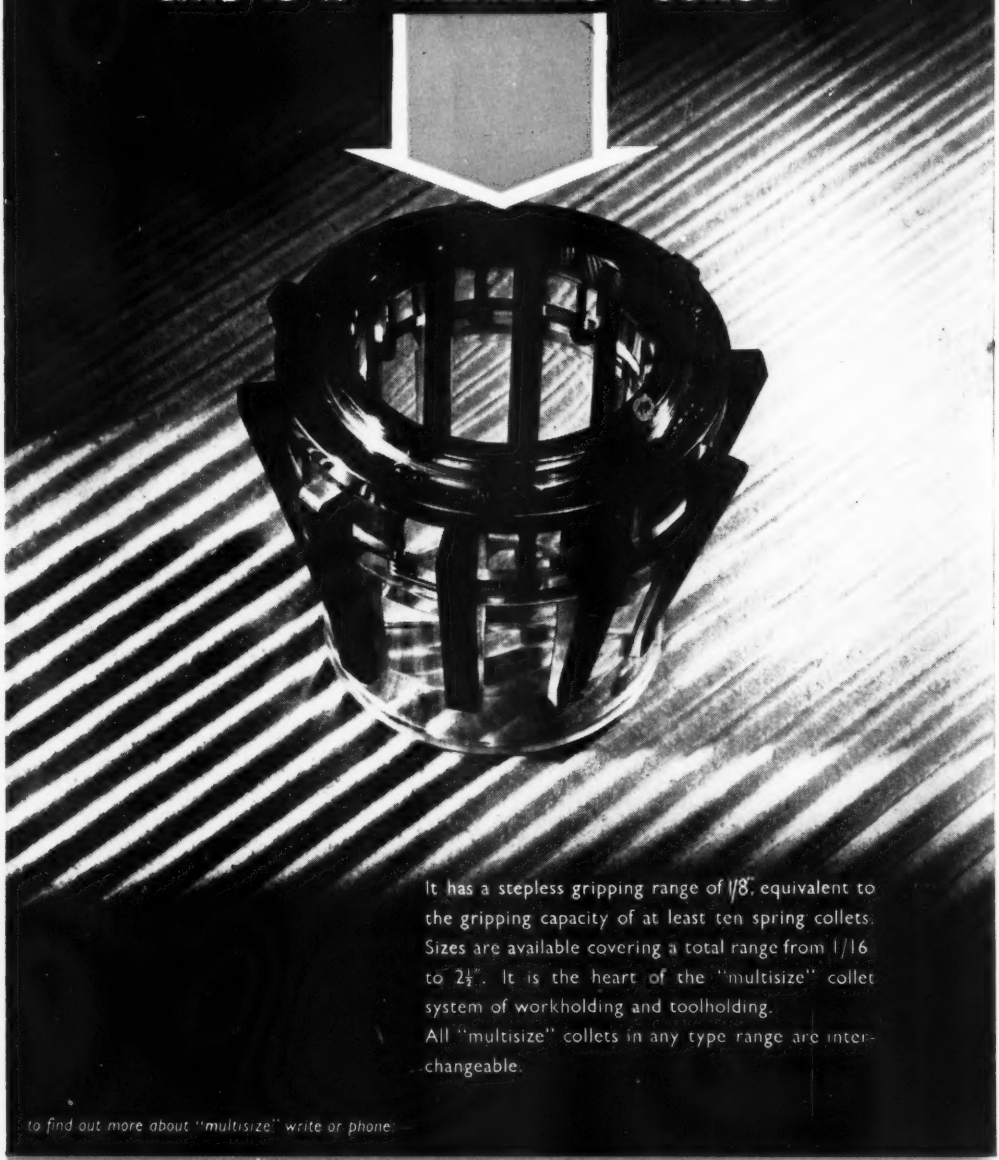
this is a "multisize" collet



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to find out more about "multisize" write or phone

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BY HAND
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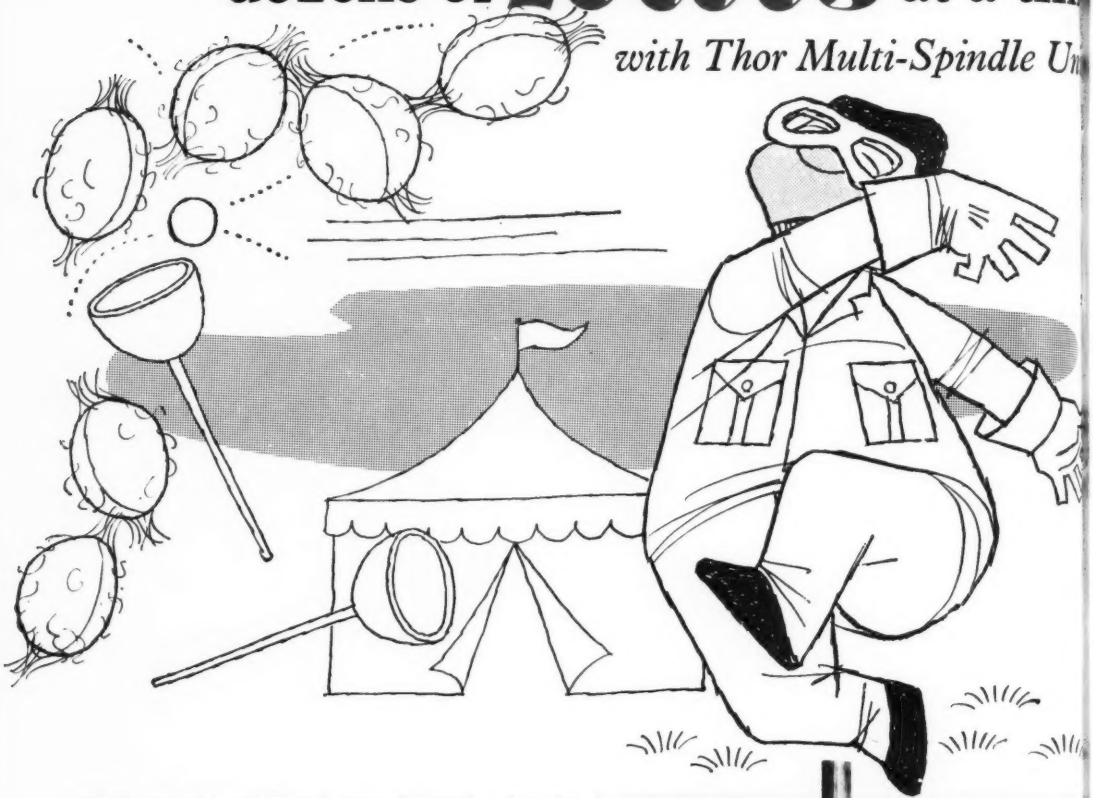
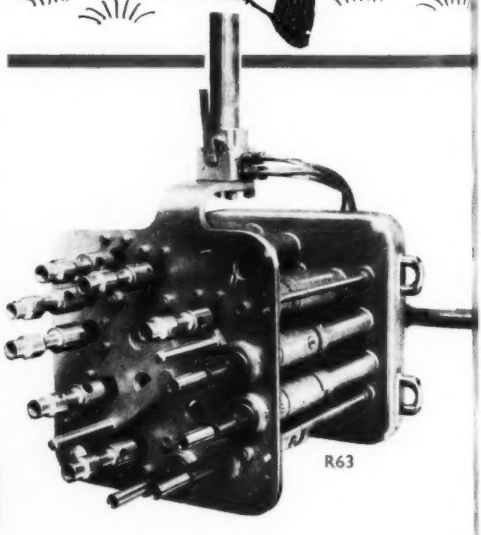
with Thor Multi-Spindle Un



Skill, *says Tommy Thor,* is passed from hand to hand, generation after generation. Thor Power Tool engineers have put it slap into the hands of everybody in industry. Today any operative can tighten nuts by the dozen. Thor Multi-spindle units can incorporate screwdrivers, studsetters, drills or impact wrenches. The latter are equally useful for dismantling.



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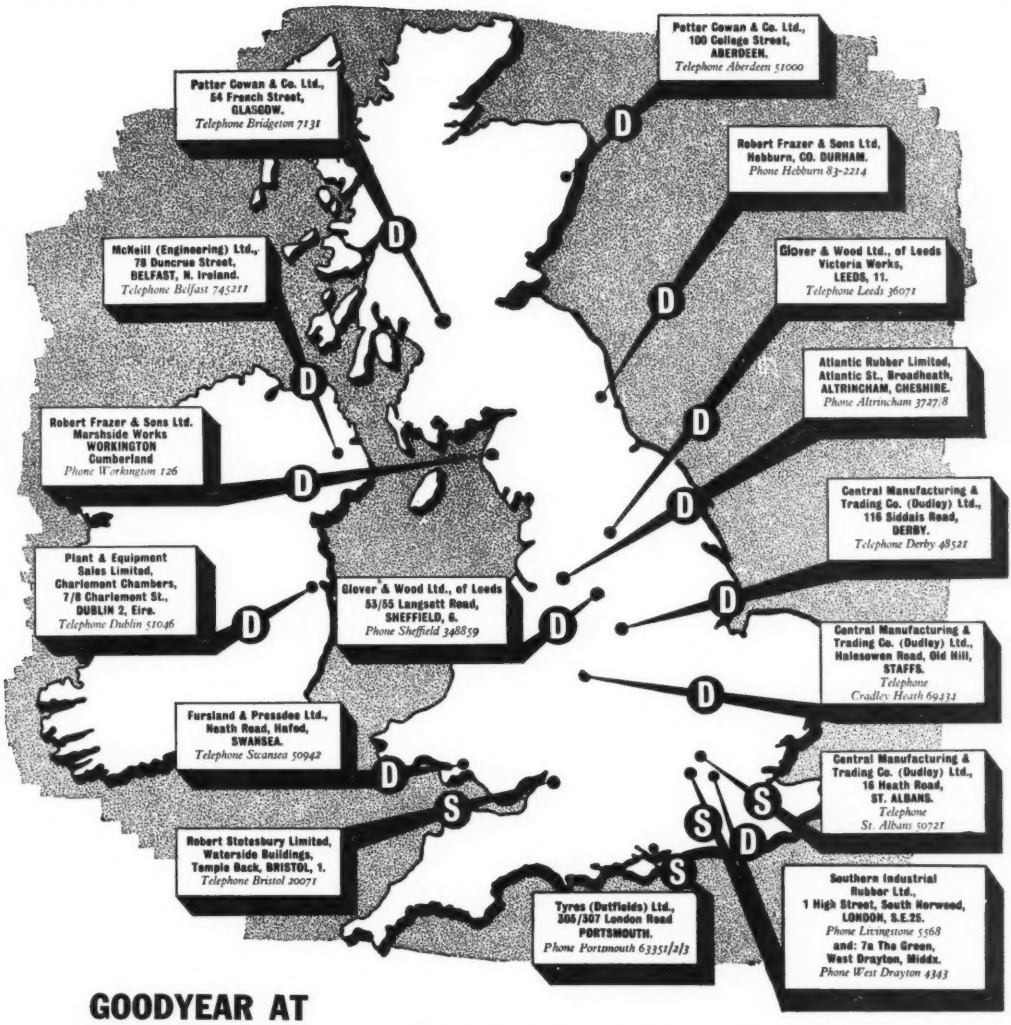
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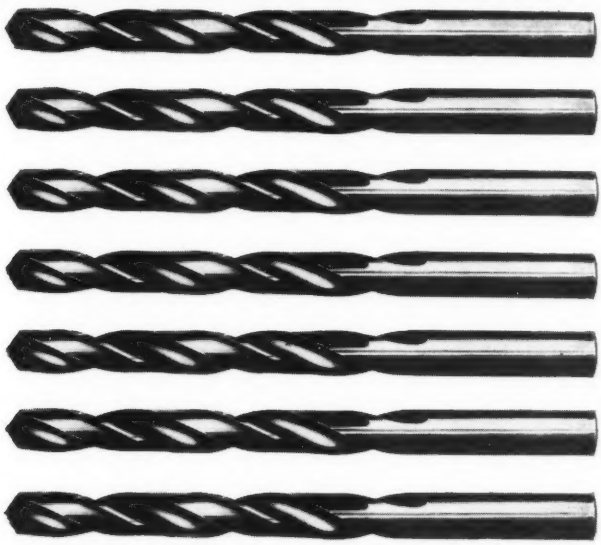

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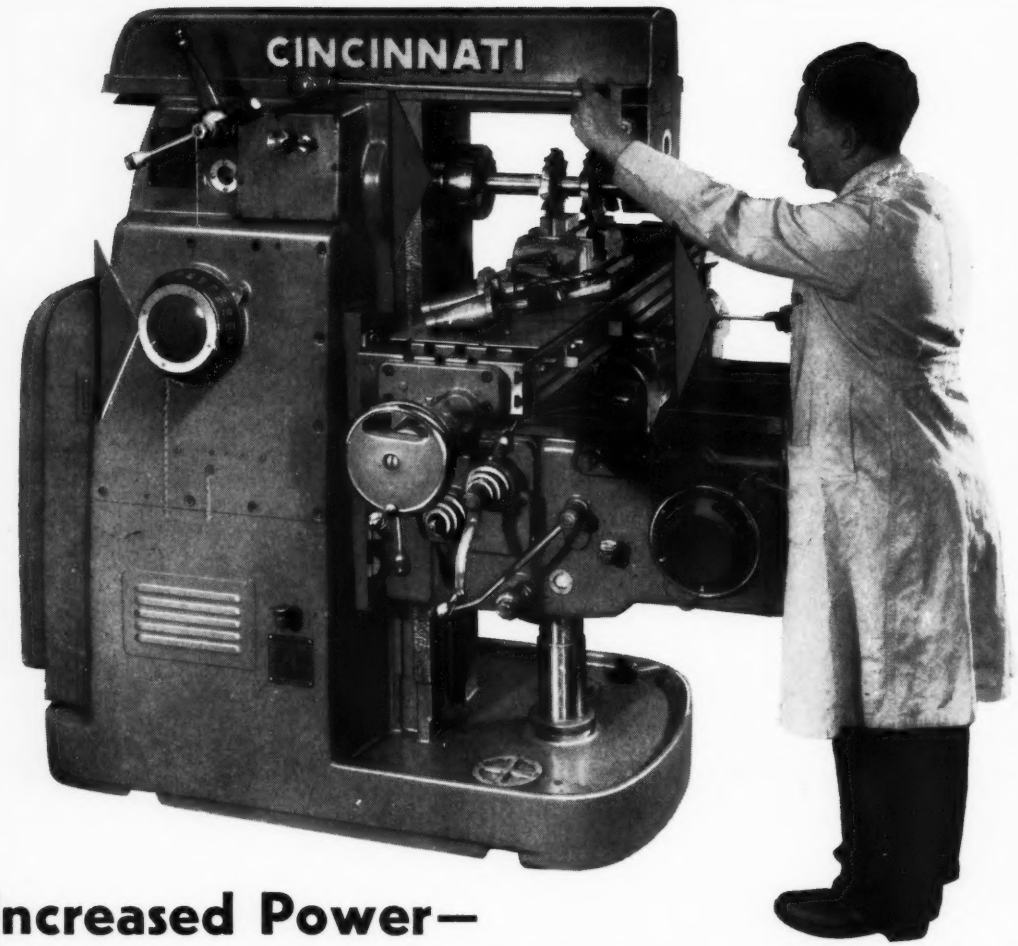

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MODEL 'ELR' 207-12 and 307-12
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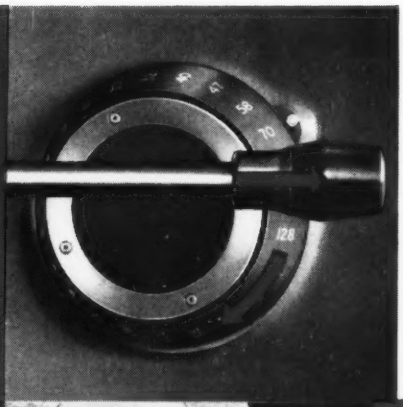
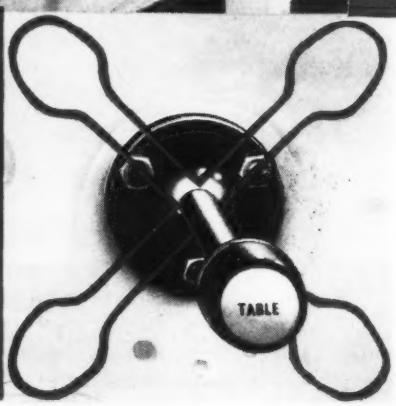


Cincinnati Exclusive Speed Change Lever. Simply pull and release. Correct spindle speeds obtained in seconds with minimum effort.

Cincinnati Exclusive ARBOR-LOC Spindle Nose Adaptor assures cutter changes in seconds—even on long arbors.

Arbor-Loc Spindle Nose

Automatic Table Cycles



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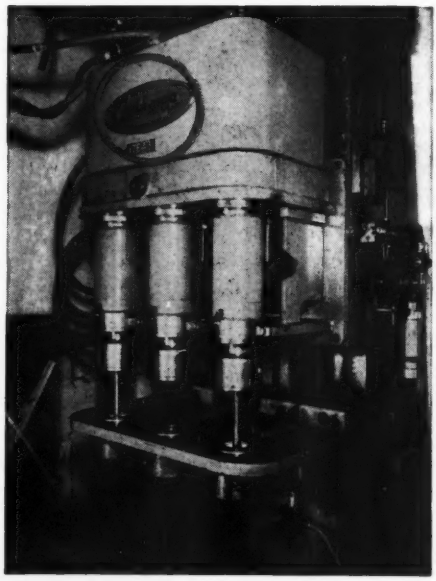
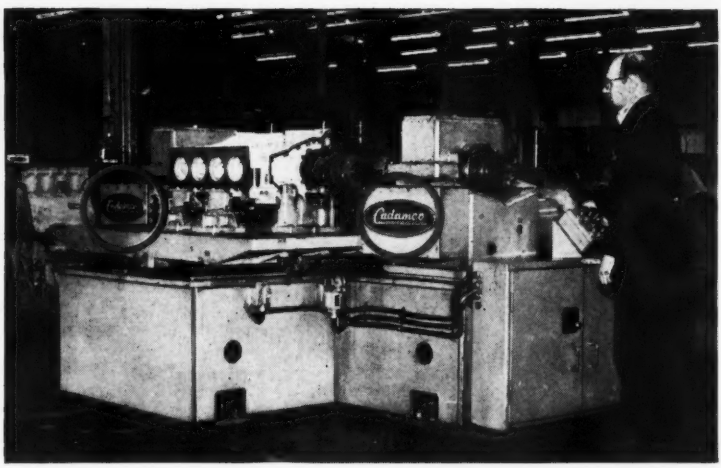
If you are seeking an enthusiastic 'out-of-the-rut' approach to your machinery problems you will find us keen to help you at a competitive price.





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We designed and manufactured this cylinder block milling machine for Caterpillar Tractor Co. Ltd. It enables twelve bearing boss faces of a Diesel engine cylinder block to be completed in one operation.

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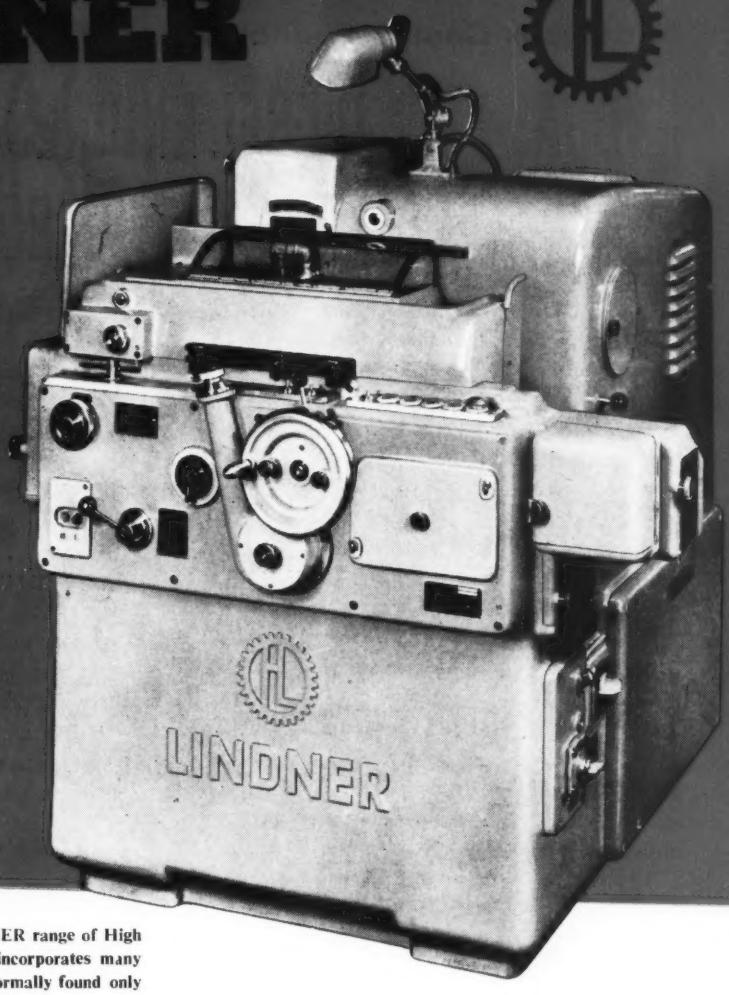
THREAD GRINDING MACHINE



This smallest machine of the LINDNER range of High Precision Thread Grinding machines incorporates many of the famous LINDNER features normally found only on larger and more expensive machines.

Two models of this highly efficient machine are available

Model A: High Precision Thread Grinding Machine of highest accuracy for the grinding of external threads and annular forms, employing either the single or multi-rib wheel, particularly suitable for producing thread plug gauges, measuring and micrometer screws.

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Both models will accommodate up to 1in. (25 mm) diameter by 7½in. (190 mm) long

Maximum length of thread ground 3½in. (90mm)

Maximum swing over table 2⅜in. (60 mm) wheel diameter 20in. approx. (500 mm).

Provision is made for grinding threads of perfect form from 200 to 6 TPI (125 mm to 4 mm pitch)

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MACHINE TOOL CO.

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Telephone: TERminus 3699

***Also at* MANCHESTER · LEICESTER · BRISTOL · GLASGOW**

Middlesex County Council chooses Regent

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Regent Ursa P is used for these engines because it maintains its consistently high quality and because it keeps its high level of flashpoint, a desirable feature for all dual fuel engines.

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URSA P

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NEW MODEL "S" SUPER CHUCK

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FASTER
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94 varieties of holders
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The illustration shows the structure of S1P grade magnified 1200 times.

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Traversing head for positioning wheel anywhere on table so that dies can be ground without removing pins. Infinitely variable hydraulic or manual table traverse. Automatic infeed for depth of cut. Guaranteed flatness of work and surface finish to 1.5 micro-inches on suitable materials. Segmental chuck available for maximum stock removal. Automatic pressure lubrication to all parts. Rapid power rise and fall of knee. Large capacity mobile coolant tank with sludge settlement tray.

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MODEL SG—4H

TABLE WORKING SURFACE

10½" UNDER WHEEL

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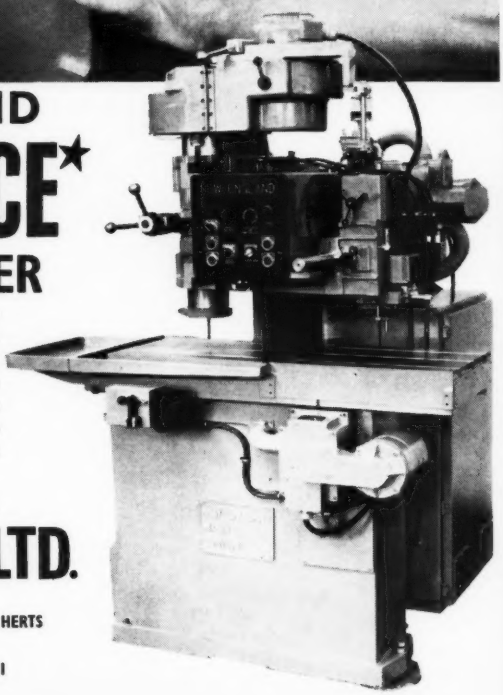

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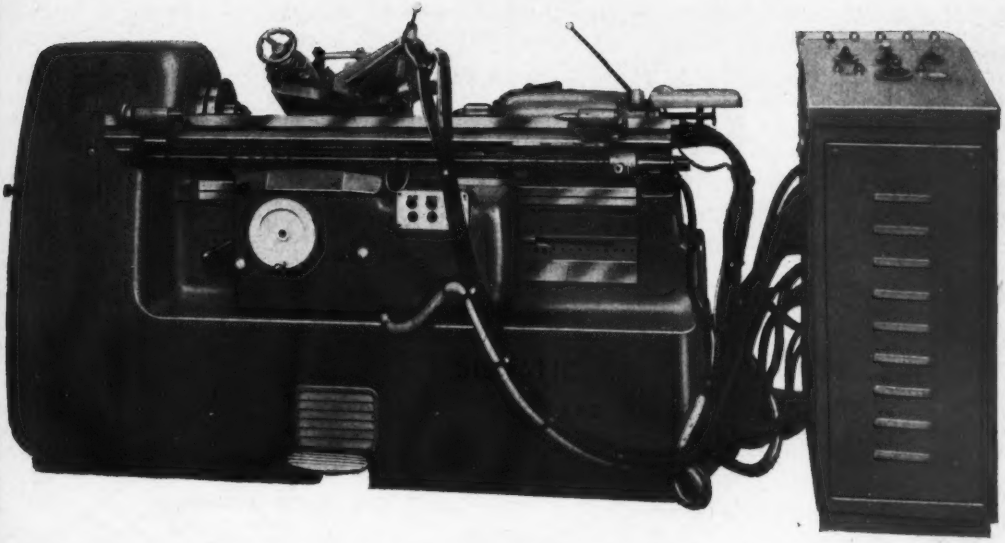

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Hardened Bed Slideways.
Auto cycling up to six depths of cut.
Hydraulic tailstock for drilling and boring.
Uses template or existing component.
Eight models to choose from.

Basic price under £2,500.

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Bore of spindle	2¼in.
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Max. swing over bed	15¼in.
Max. swing over saddle	9¾in.
Max. length turned	27½in.
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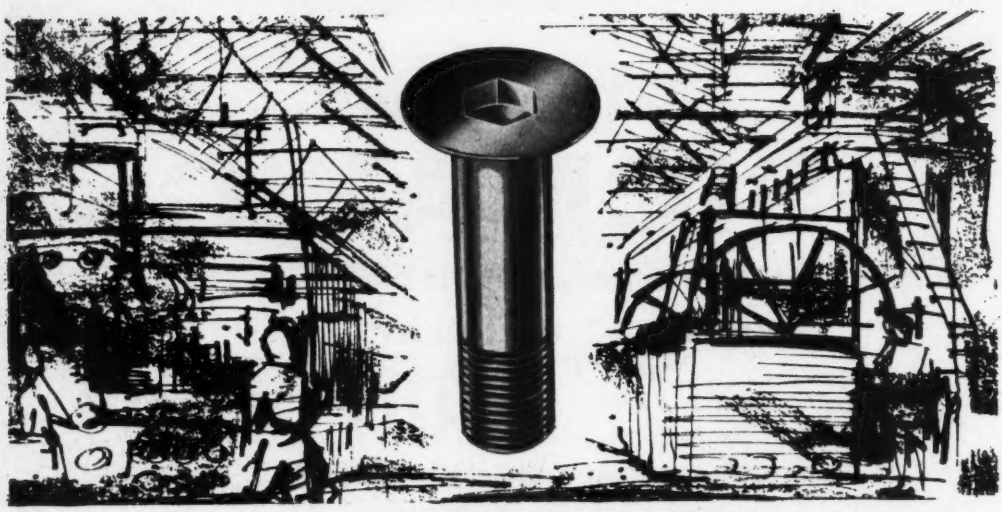
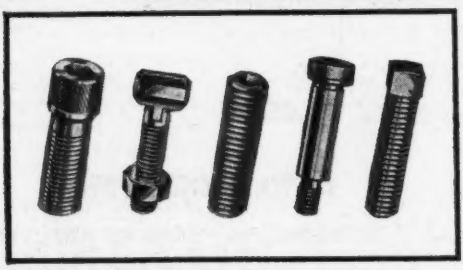
Reliability stems from research. No screw in the whole wide world is backed by more research than Unbrako.





Unbrako high-performance countersunk screws are made in a vast range of sizes and threads to cover every need. A descriptive brochure is yours for the asking.

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Multi Spindle Drilling Machines

3 SIZES AND 6 POWER CAPACITIES

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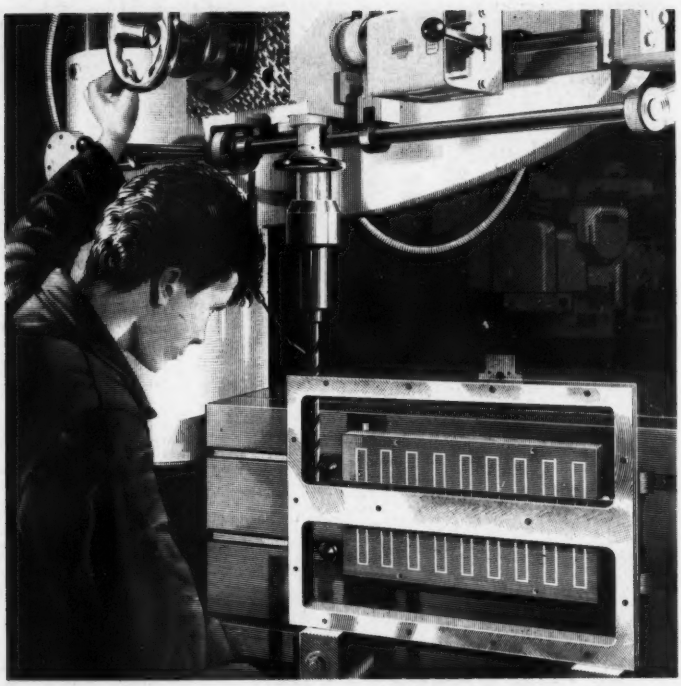

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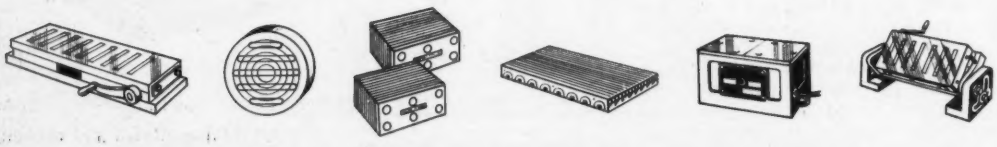

users' handbook and technical specifications available on request

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Long. Trav.	20"	26"	29"
No. of Speeds	12	9	18
Speeds R.P.M.	32-1000	60-1200	40-2000
Spindle Nose	No. 40	No. 40	No. 40
PRICE ★	£880	£1100	£1825

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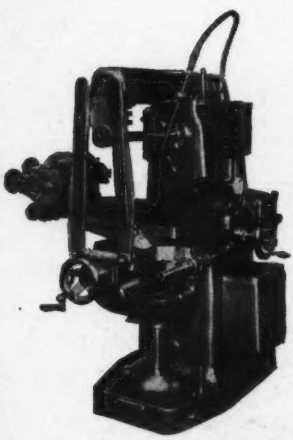
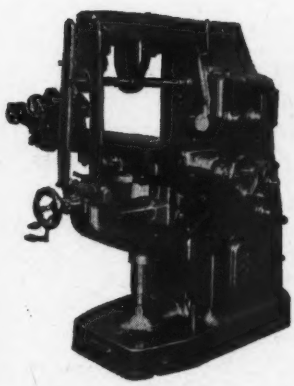
UNIVERSAL MILLING MACHINES

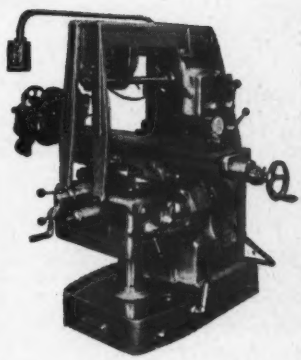
Model 0



Model 1



Model 2



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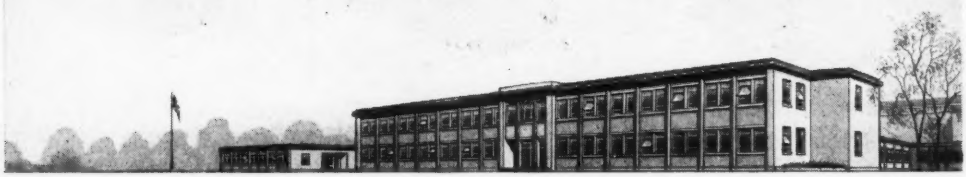

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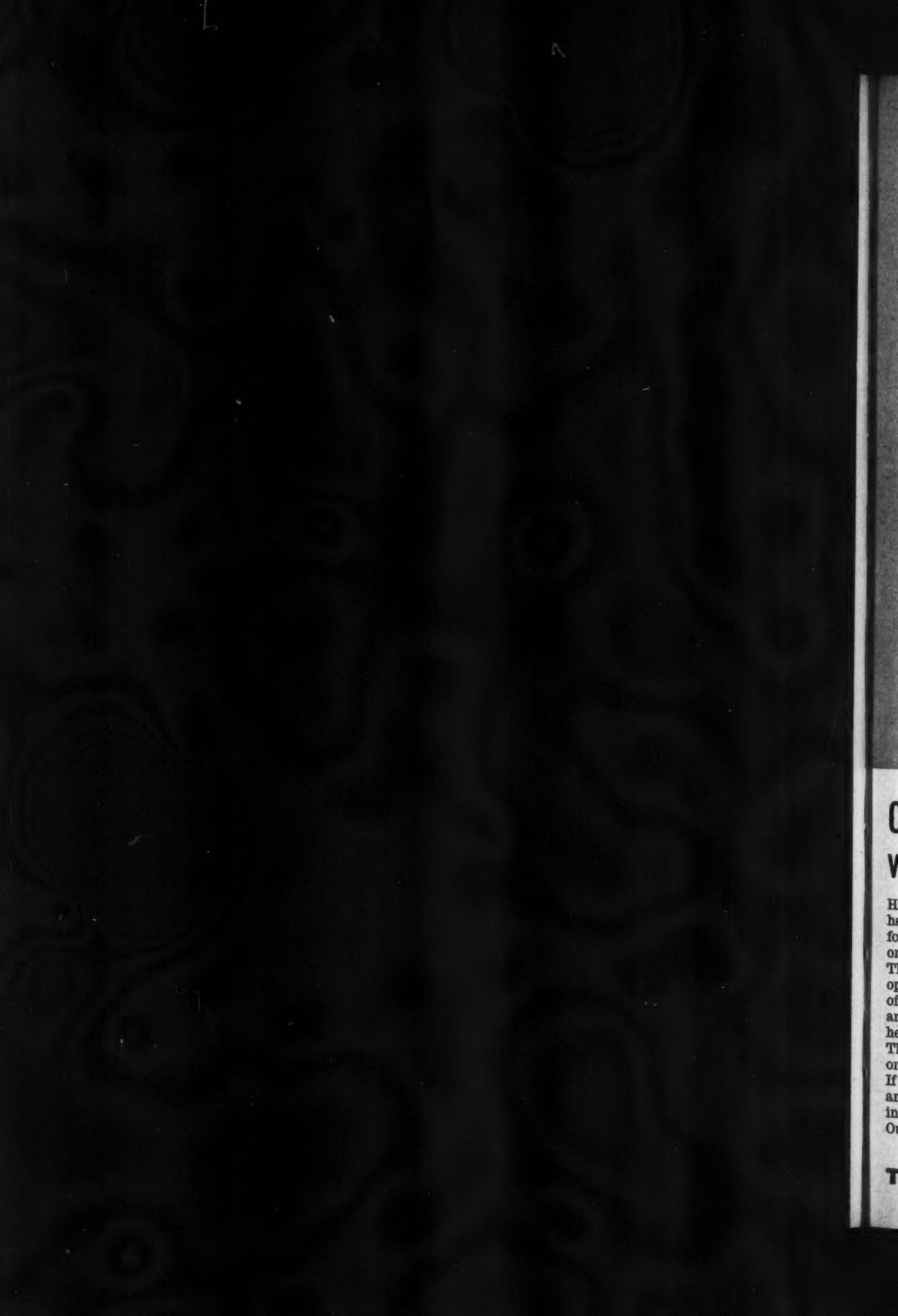

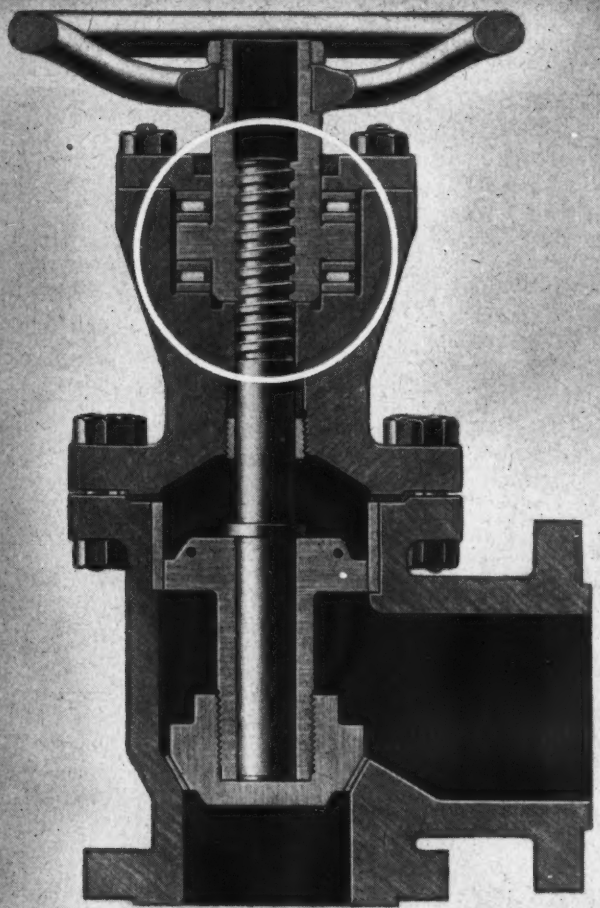

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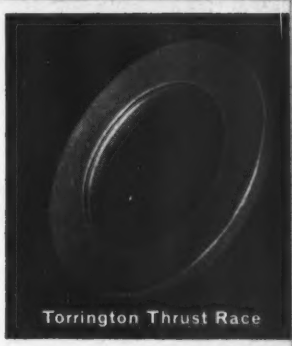

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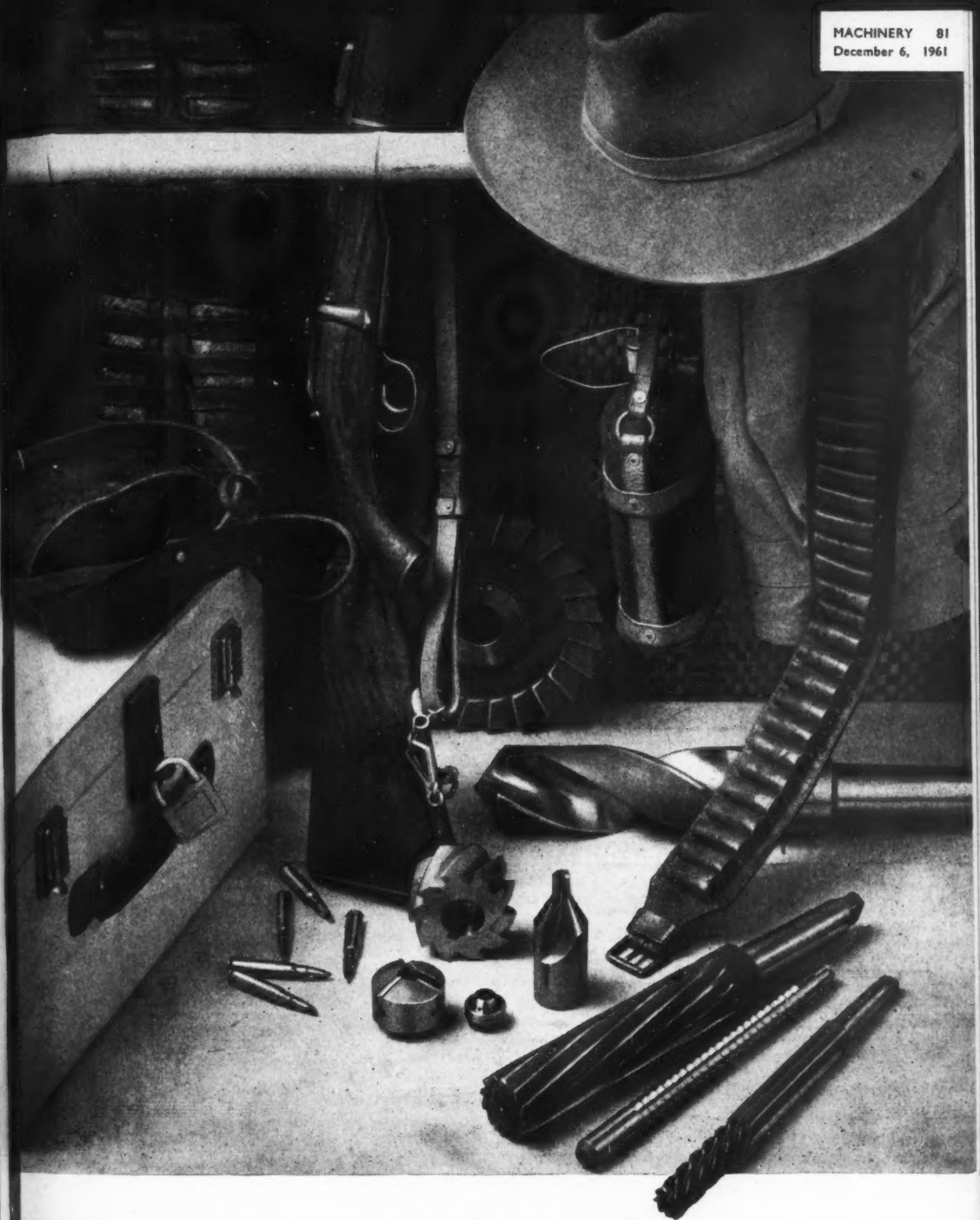

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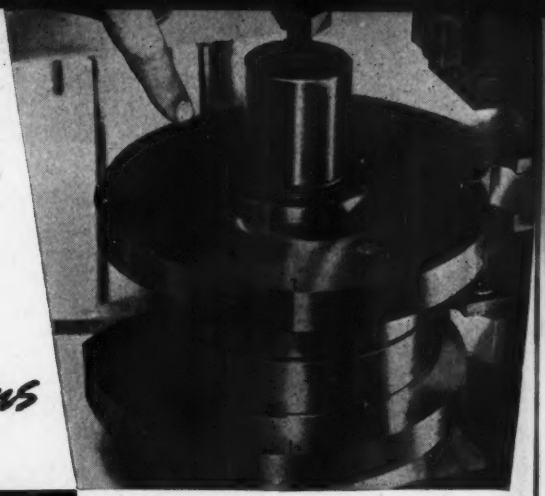
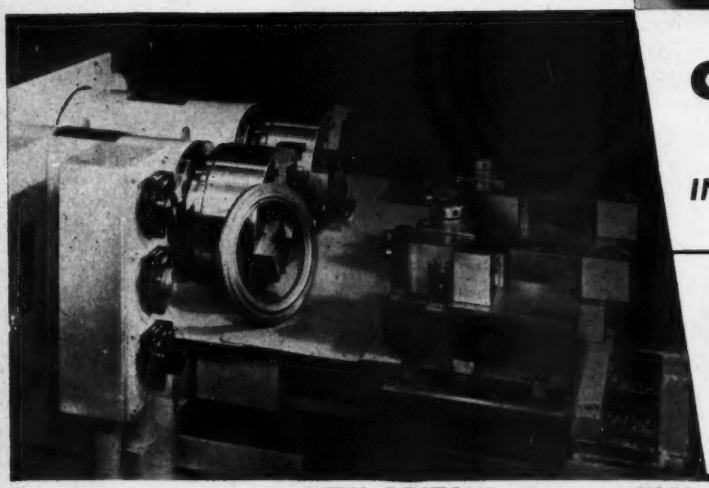
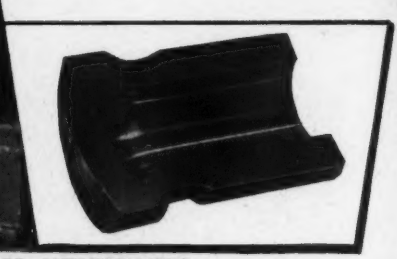




CAMS *PUT THE* PRECISION *INTO PRECISION BORING*



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When working to "tenths" cams are the best method of maintaining accuracy, because cam control of the tool is *positive* control. The accuracy of parts produced on New Britain boring machines can't be affected by variable hydraulic pressures, ambient temperature, or play in complicated linkages.

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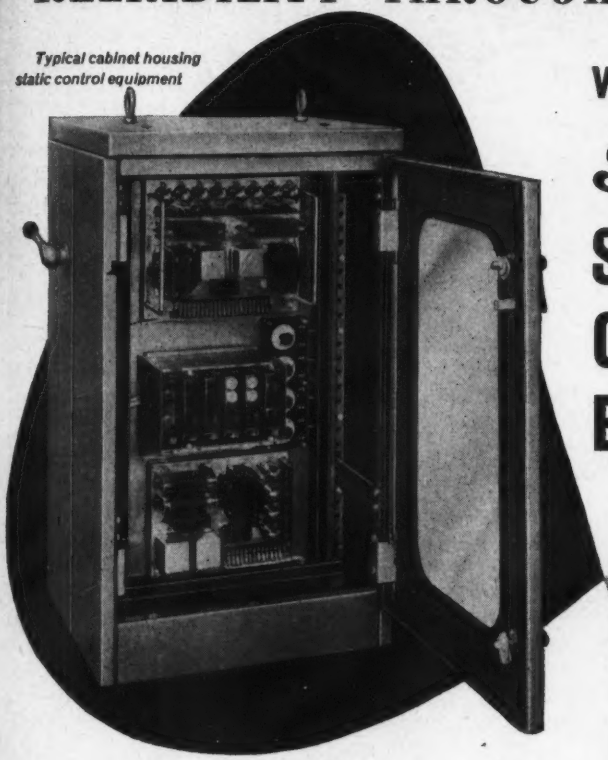
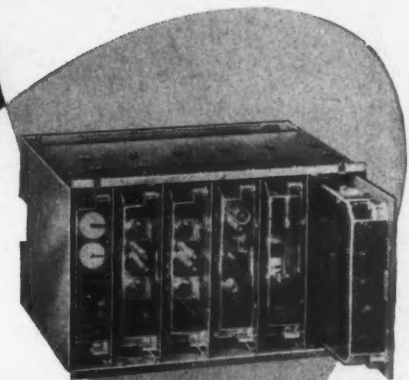


Typical cabinet housing static control equipment

with G.E.C. STATIC CONTROL EQUIPMENT



Sub-assembly of six static control units shows one unit partly withdrawn

The GEC static control system provides automatic control of any number of operations in which the basic requirement is the operation of electrically motivated hydraulic and pneumatic valves and other similar devices in a pre-determined sequence. The control system consists of interconnected sets of several types of standard units, the complete equipment controlling the order in which cycles of operations are carried out.

The entire system is housed in a cabinet, with terminal blocks for easy connection to the equipment to be controlled. The control panel, with start switch, cycle-selector switch, manual controls and indicator lamps, can be incorporated in the cabinet or fitted remotely.

The inherent reliability of the control system is largely due to the almost complete elimination of moving parts. Faults can be traced immediately, and, as units are interchangeable, only a small number of spares need be carried.

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...and you can make your own die sets - *but it's better to buy from* **Desoutter**

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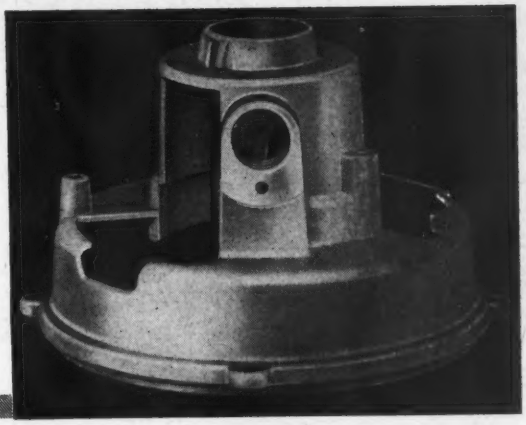
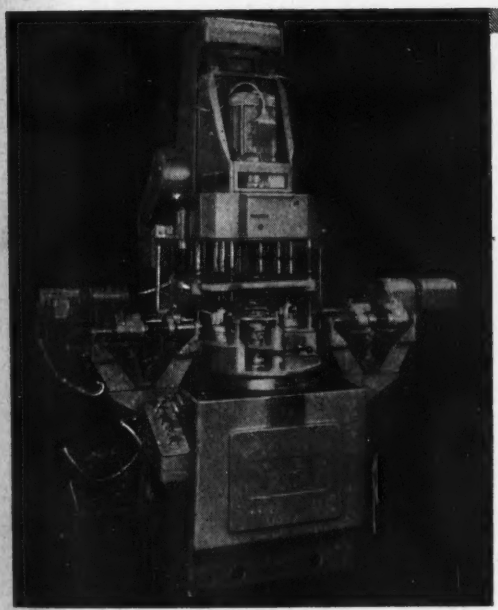


Working with the MULHEAD Mk IV ROTARY AUTOMATIC



By successfully solving such production problems, this standard versatile high-speed machine raises output and reduces cost. It can probably do so for you.

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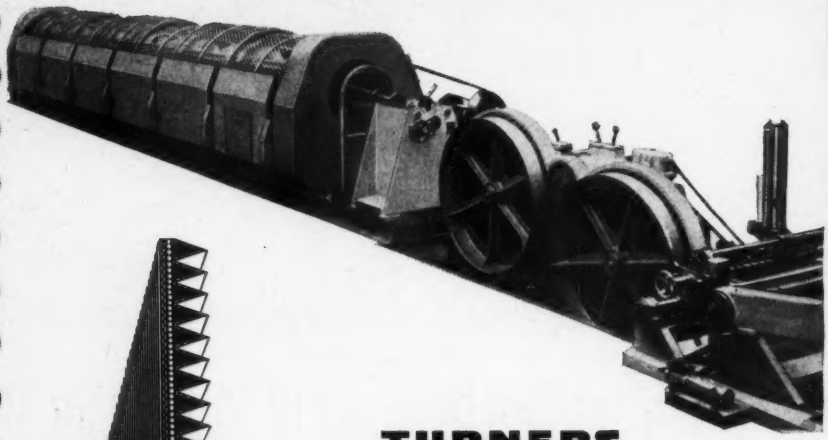

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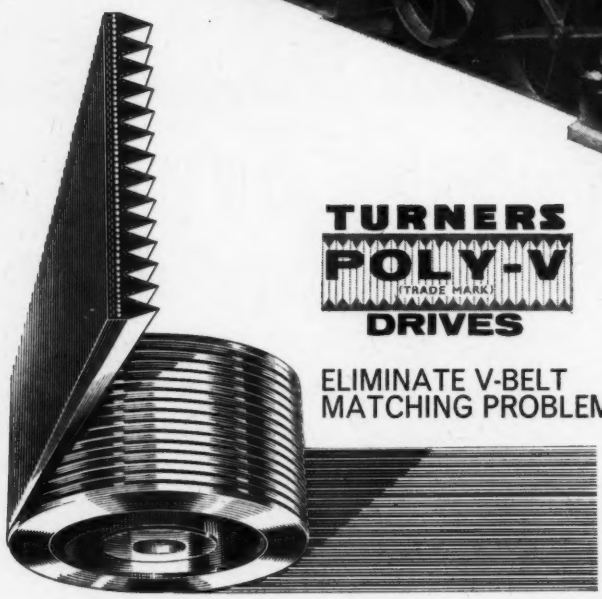
POLY-V (TRADE MARK)
DRIVES

ELIMINATE V-BELT MATCHING PROBLEMS



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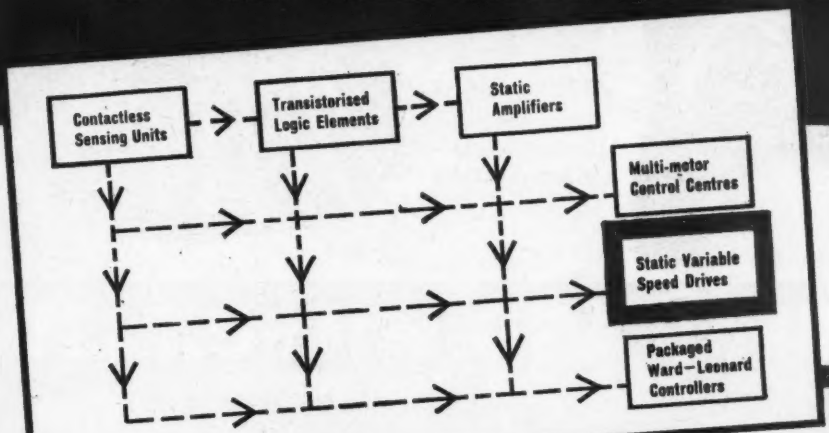

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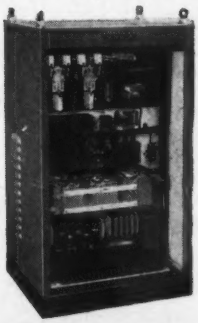

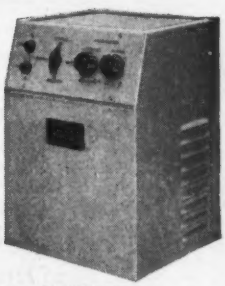

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¼ to 150 horsepower
20:1 speed range
4% of top speed regulation

A wide range of optional extra facilities including more accurate speed control available if required.

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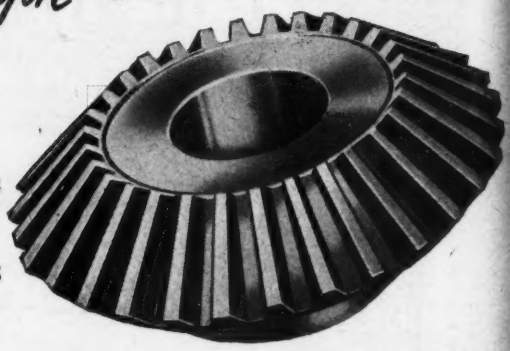

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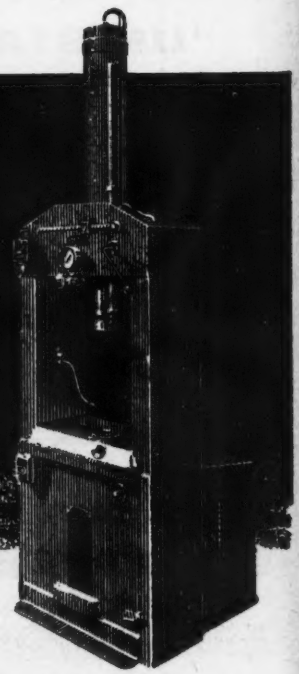

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Highest Quality at Low Cost—plus Quick Delivery

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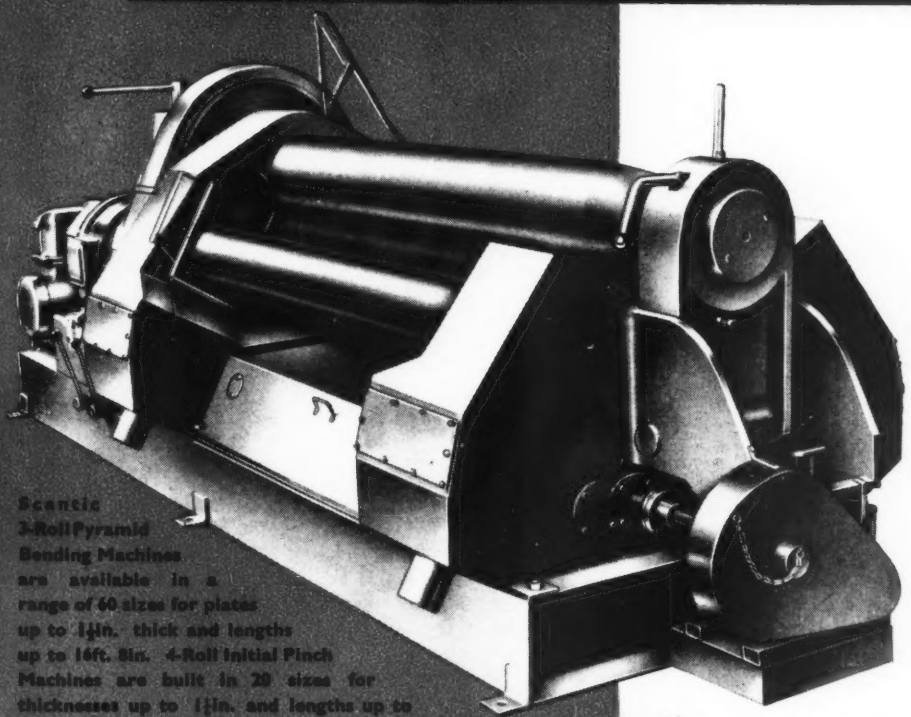
Plate Bending Rolls



Scantic 3-Roll Pyramid Bending Machines are available in a range of 60 sizes for plates up to 1¼in. thick and lengths up to 16ft. 8in. 4-Roll Initial Pinch Machines are built in 20 sizes for thicknesses up to 1¼in. and lengths up to 11ft. 7in. The machines are of all-steel welded construction with forged steel rolls running in heavy phosphor bronze bearings. Controls are simple and conveniently arranged. On 3-roll machines hand or power adjustment to the top roll can be supplied as required. On 4-roll machine power adjustment of side rolls is standard and bottom roll adjustment optional.

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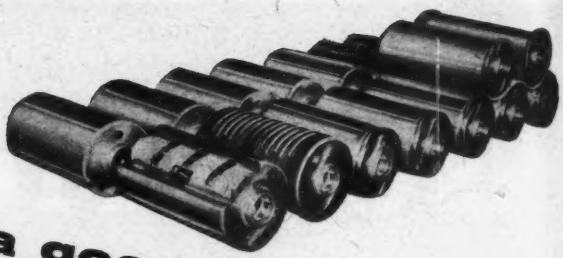
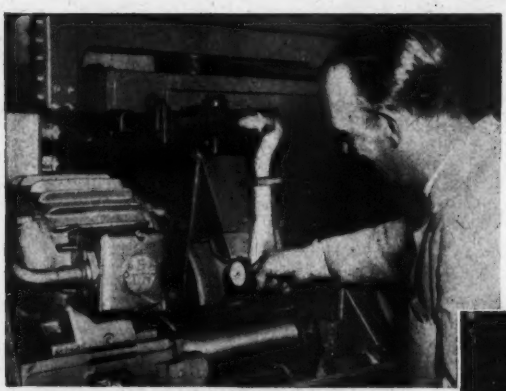
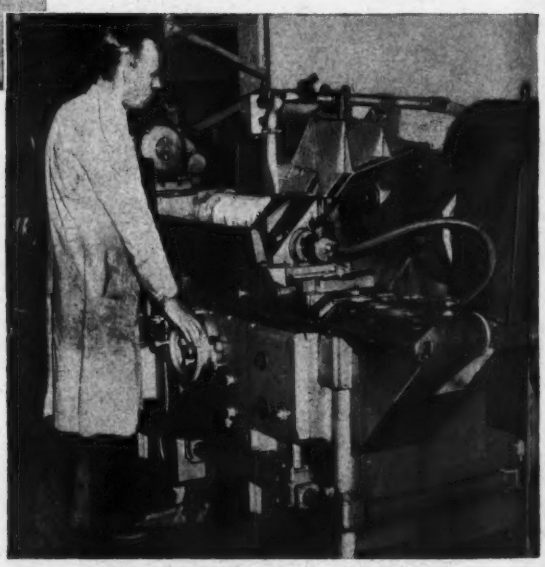


maintaining a good impression!



GRINDING THE
PRINTING CYLINDERS
FOR *Gestelith*
OFFSET DUPLICATOR



The new 'Gestelith' offset duplicator represents a decisive advance in office printing equipment.

Prominent features are the chromium-plated printing cylinders.

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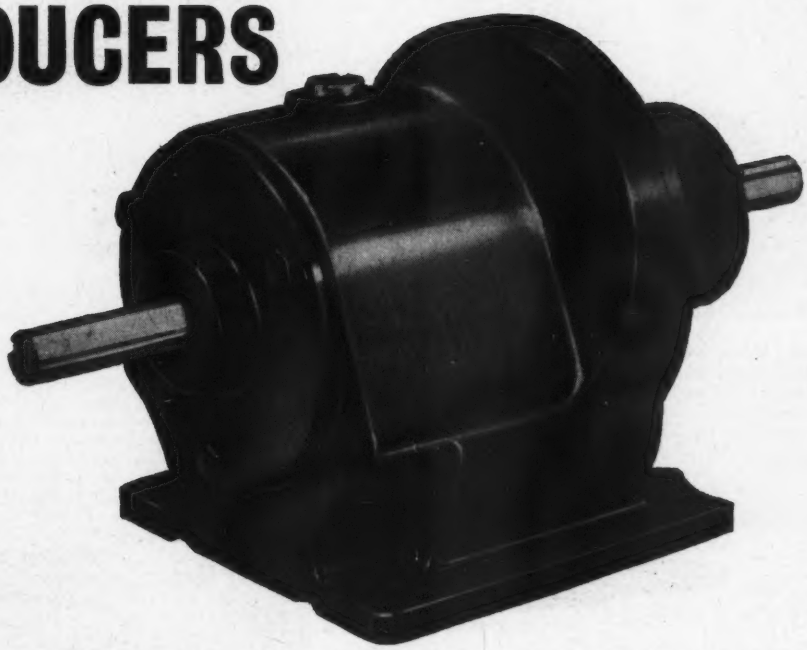

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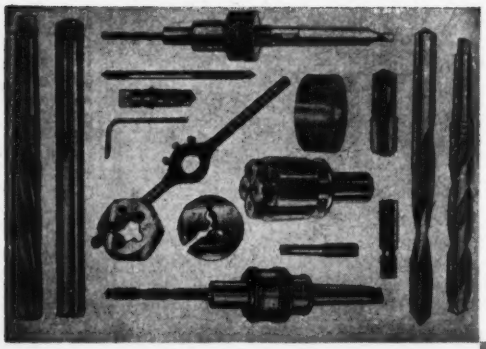

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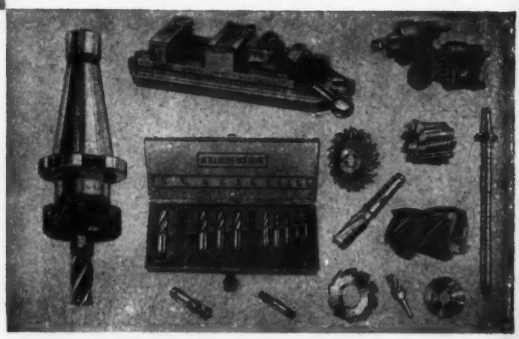

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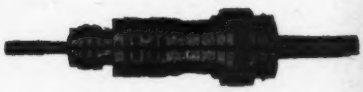

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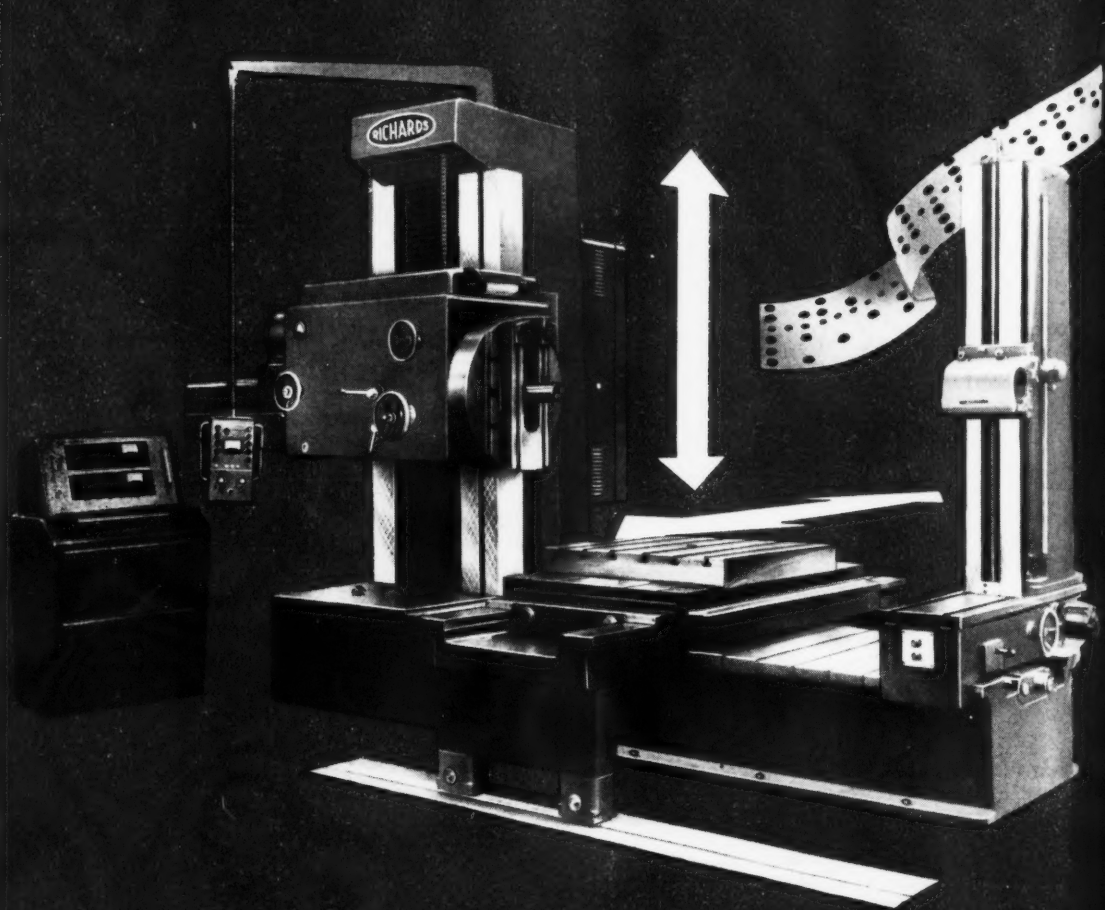

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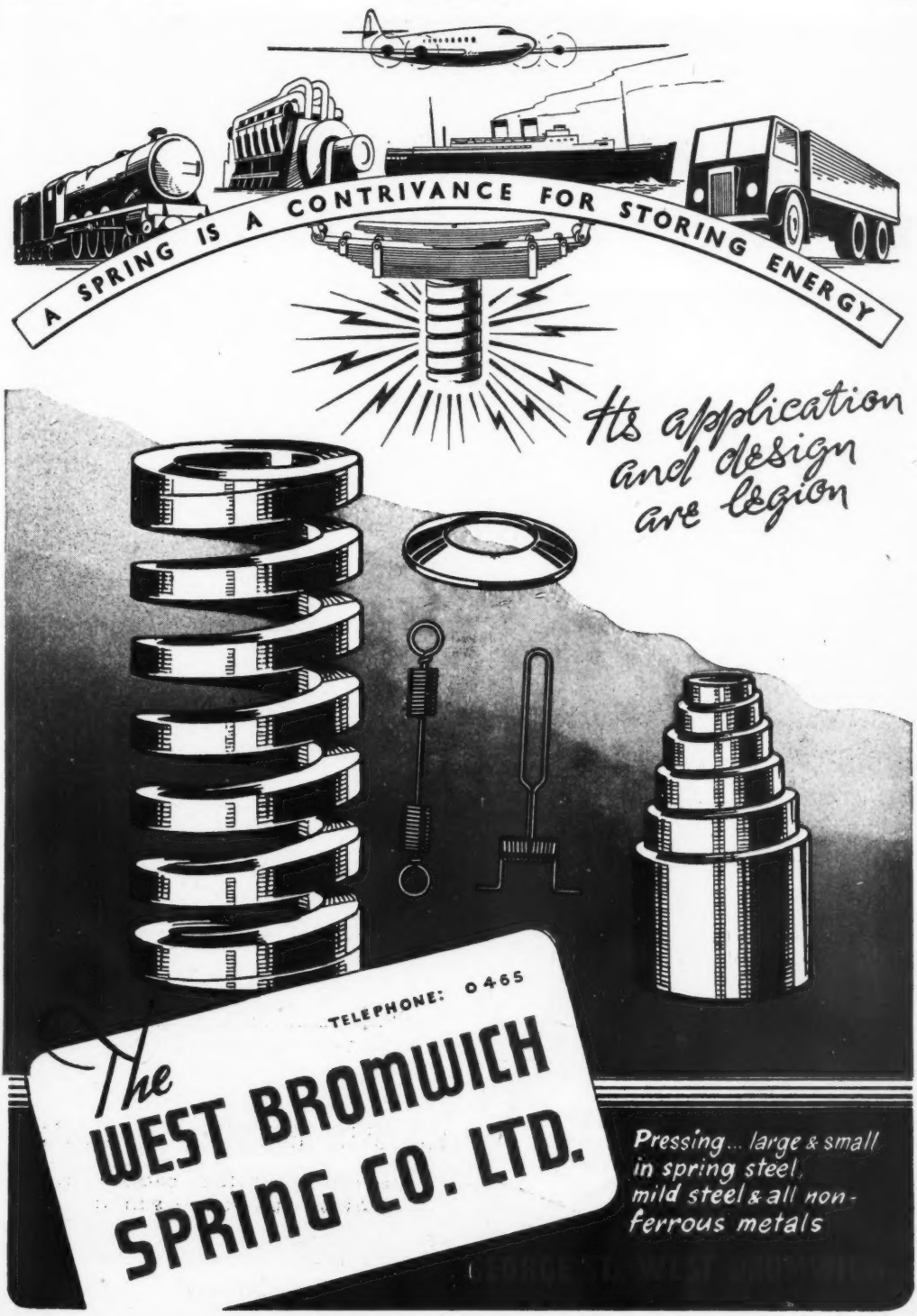
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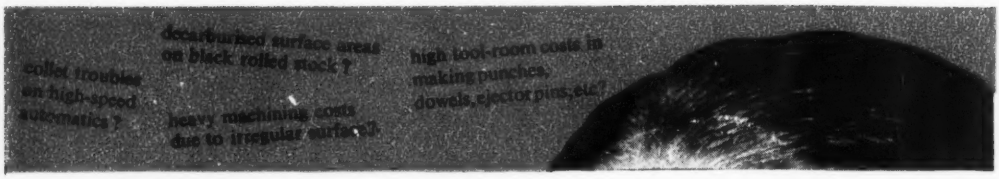
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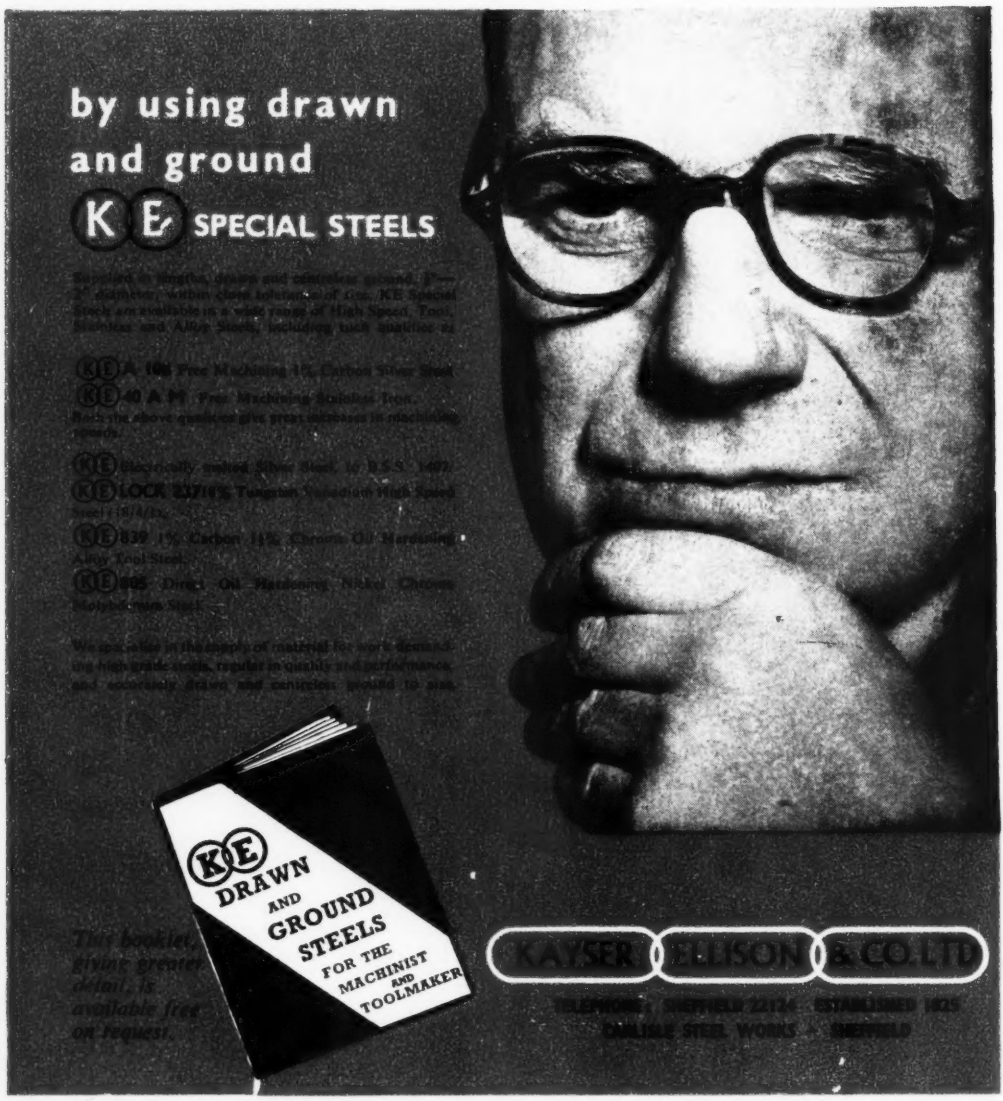

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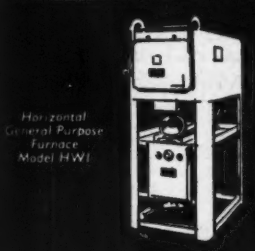

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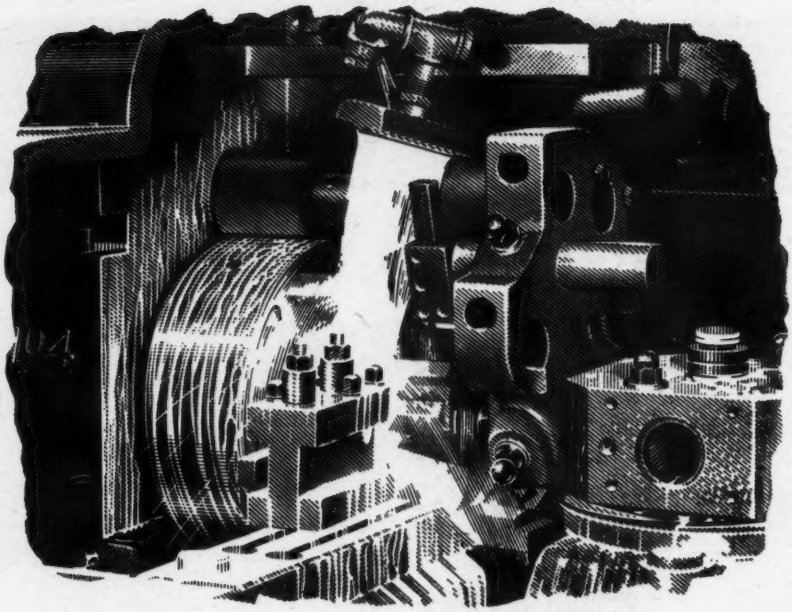

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Abstracts of Principal Articles

The Manufacture of Slip Gauges .. P. 1296

This third article of a series is concerned with the methods employed by VEB Carl Zeiss, Jena, East Germany, for the production of slip gauges, of which about 1,000 sets are made per year. Slip gauges are supplied in sets containing 45 and 86 pieces, in metric sizes only, to the DIN specification grade 0. After cutting to length on an automatic saw, the blanks are heat-treated and aged to ensure dimensional stability. Surface grinding of all surfaces follows, after which rough lapping brings the overall length to within 0·003 mm. of the required size. Lapping is carried out on Zeiss-designed machines on which movement is imparted only to the work-carrier plates. Etching follows, and the edges are chamfered on a special grinding machine before the gauges are returned for finish lapping. Specially heat-treated laps, with surfaces in which iron phosphides are embedded, are employed for finishing operations, without abrasive, and the gauges are finally inspected on Zeiss equipment. (MACHINERY, 99—6/12/61.)

Evaluation of the Effects of Spline Misalignment .. .. P. 1312

The second of two articles on the effects of spline misalignment, of which the first was published in MACHINERY, 99/856—11/10/61. Consideration is here given to the different conditions which arise when the externally splined member is crowned, notably in connection with the contact surfaces. The equation for calculating the clearances for crowned splines is given, and detailed instruction is presented on the effects of hardness values on the load carrying capacities of splined shafts. Comparisons are also drawn between the load carrying characteristics of straight and splined connections. (MACHINERY, 99—6/12/61.)

Some Advantages Gained from Flow-production of Russian 1T62 Lathes.. P. 1318

As is now well known, type 1T62 lathes are built at the rate of 12,000 per year at the Krasnyi Proletarii works, Moscow. In this article, reference is made to some of the effects of the introduction of flow-production methods some years ago. For example, it is claimed that the man-hours required to build a lathe were reduced by 30 per cent, and that output was increased by 37 per cent. Brief mention is made of the heavy press shop, the machine shop, the assembly lines, and the paint shop, also of the various increases in productivity and reductions in man-power which have been achieved. (MACHINERY, 99—6/12/61.)

Transplant-coated Aluminium Cylinder Bores .. .. P. 1323

To form a hard coating in the bores of cylinders of pressure die cast cylinder blocks, a new system known as Transplant-coating has been developed. With this process, a coating of metal is sprayed on to the core employed to form the cylinder bore in the die casting die. Subsequently the core is withdrawn, and the coating remains in the casting. An excellent bond, of very high strength, is obtained between the coating and the casting, and tests to determine the strength of the joint all resulted in failure of the coating and not of the bond. Examination of a cylinder bore in an engine which had been run for 975 hours at 7,000 r.p.m. showed no signs of scuffing, and wear did not exceed 0·002 in. (MACHINERY, 99—6/12/61.)

Redman 35-ton Hydraulic Press .. P. 1326

A new 35-ton hydraulic press has recently been introduced by Redman Tools & Products, Ltd., Worcester, and is specially designed to enable a variety of standardized tool assemblies and units to be changed rapidly. Provision is made for use of items from the company's range of Unipierce and Unicrop standard tools, so that nibbling, notching, and embossing operations can be performed. Full details, including a sectional drawing, are given of the stripping head and tool-holding arrangements. (MACHINERY, 99—6/12/61.)

New Range of Dixi Jig-boring Machines with Numerical Control .. .. P. 1329

Shown for the first time at the 7th European Machine Tool Exhibition, held recently in Brussels, the new range of Dixi (Swiss) jig-boring machines can be arranged for numerical control, dimensions being set either by endless punched-tape, perforated strips, or manually by means of a bank of push-buttons. Certain design changes to the spindle head and twin columns have been made, and a new spindle drive system is employed whereby all gears, with the exception of a 2-stage helical reduction, have been eliminated. The spindle is driven directly, from the rear, and is therefore subjected to torque only. No axial traverse is provided for the spindle, longitudinal feed for boring being obtained by traversing the work towards the spindle. (MACHINERY, 99—6/12/61.)

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EDITORIAL

Developments in Programming Methods for Numerical Control

There is now a wide choice of systems for the numerical control of machine tools of various types not only for the accurate positioning of tables, slides, and heads, but also for continuous guidance of tool motions for the production of irregular forms in two or three dimensions. The practical performance of many of these systems has been fully established, and a considerable number of machine tools has already been introduced, particularly in the U.S.A., to enable their potential advantages to be utilized effectively. Especially as regards continuous path control, however, progress in application—at least in this country—still appears to be painfully slow.

It cannot be disputed that the ability to produce accurate 2- and 3-dimensional forms without the previous preparation of templates or masters can often be of great value, particularly where only small quantities or even single pieces are required. Admittedly the cost of the machines and equipment necessary to enable such operations to be performed under numerical control is high. It has been shown, however, that owing to reductions in set-up and other idle time a much higher degree of utilization can be achieved, particularly in comparison with a machine that is operated entirely under manual control. Provided that numerically controlled equipment is kept in operation for a sufficient number of hours each week it should be possible, therefore, readily to justify the high initial outlay.

For automatic operation under numerical control, it is necessary, of course, to provide explicit instructions, and the required information is normally transmitted by way of magnetic or punched tape, or punched cards. For continuous path control, for the production of 2- or 3-dimensional forms, the preparation of tapes is enormously facilitated—indeed, it is frequently only made practically possible—by the use of computers. Nevertheless, preliminary programming is necessary before the computer can fulfil its function, and it appears that many potential users of numerically-controlled machines are still deterred by doubts as to their ability to undertake this work successfully, despite repeated assurances that the solution of the problems involved presents no particular difficulty. In this connection it must be recognized, moreover, that, regardless of the skill and experience of the individuals concerned, the preparation of a programme for a complex 3-dimensional workpiece may involve very considerable time and expense. It follows that if only a single workpiece is required, such as a component for an elaborate die or mould, the advantages of numerically-controlled machining may be at least partially offset by the magnitude of the programming work that must be undertaken.

In this particular field of tool-room work, however, fully automatic machining can offer special benefits, and it is very important, therefore, that all possible methods whereby the work of the programmer can be further simplified and expedited should be fully explored. In practice it has been found that without departing from established principles, many short cuts can be taken to facilitate the introduction of frequently recurring forms in programmes for both 2- and 3-dimensional workpieces. As a simple example, it may be noted that codes can conveniently be adopted for a variety of 2-dimensional forms, such as a straight line between two co-ordinate points; a straight line and circular arc intersection; a straight line tangent to an arc; two intersecting straight lines; and two adjacent, tangential, circular arcs.

A considerable further advance in the direction of simpler and more rapid programming, it is claimed, has been achieved with the introduction of a system whereby the form required is described largely in words which are taken from a vocabulary that has been compiled, and are used in accordance with certain "grammatical rules". This vocabulary, it is stated, now comprises about 250 words which serve to describe shapes such as a cone, a cylinder, a hyperbolic paraboloid, a sphere, or a taurus, also to indicate, for instance, an angle, an axis point, or an intersection, and these words can be built up into "sentences" and "paragraphs". As a very simple example of the procedure followed, it may be noted that the statement "hollow = sphere, inside/centre (0, 0, 8), radius (5)," indicates a spherical depression with the centre on the Z axis at a distance of 8 in. from the origin, and a radius of 5 in. Another statement in the programme might be "external at/(3, 0, 4), +Y direction, left" to indicate that machining is to start at a point with co-ordinates of 3 in., 0, and 4 in., which lies on the external boundary of the area to be machined, that the tool point is to move initially in the positive Y direction, and that the area to be machined lies to the left of this starting direction.

(*Continued on page* 1342)

The Manufacture of Slip Gauges

Methods Employed by VEB Carl Zeiss, Jena, East Germany

By R. E. GREEN, Associate Editor

TWO ARTICLES, PREVIOUSLY PUBLISHED in MACHINERY, 99/652—20/9/61, and 99/842—11/10/61, were concerned with the history and current activities of the large organization of VEB Carl Zeiss, Jena, Thuringia, East Germany. Employing some 18,600 people, the Zeiss organization occupies three factories in Jena, in addition to several smaller works in surrounding towns, and makes more than 2,000 different products, including a wide range of precision measuring apparatus, examples of which have been described in MACHINERY from time to time. The range includes slip gauges, which are produced at the rate of about 1,000 sets per year, and some of the machines and methods employed for this work are here described.

ZEISS SLIP GAUGES

Zeiss slip gauges are made in sets containing 45 and 86 pieces, in metric sizes only, and are finished in accordance with the requirements for grade 0 of the German DIN 861 specification. This specification lists four degrees of accuracy for slip gauges, of which grade 0 is the highest, and gauges in this grade are held to limits of $\pm(0{\cdot}1 + 0{\cdot}002 \times$ nominal length) microns. In accordance with this formula, a gauge of 0·5 mm. (0·0196 in.) nominal length is required to be held to ±0·1 micron (0·000004 in.), and a gauge of 10 mm. (0·3937 in.) to ±0·12 micron (0·0000048 in.), the tolerance increasing by ±0·02 micron for each 10 mm.

Variations from the mean size of a gauge due to face errors must be held to 0·1 micron (0·000004 in.) over the range of sizes up to 200 mm. (7·87 in.) nominal length. These figures compare approximately with those given in British Standard 888:1950 for the calibration grade of slip gauges, which specifies that the lengths of gauges up to 1 in. nominal size must be held to ±0·000005 in., the limits for larger sizes being 0·00005 in. per inch of length. Such gauge blocks are normally used as master or reference sets, to

check shop standards, when new, and are put into shop use only when their accuracy has deteriorated a little, due to wear.

Although the Zeiss catalogue lists only grade 0 slip gauges, certain of the finished gauges are closer to the nominal dimensions than is called for by this specification. Such gauges are put aside and are subsequently made up into special sets which are referred to as grade 00, and these may be regarded as approximately equivalent to the reference grades in the B.S. specification quoted earlier. Although the DIN 861 specification permits a 1-mm. wide zone of lesser accuracy along each edge of the measuring faces, Zeiss gauges are finished in one plane almost up to the edges of the main chamfers, to ensure greater accuracy in use, and longer life.

PRELIMINARY OPERATIONS

Zeiss slip gauges are made from steel containing carbon 1, chromium 1·8, and manganese 0·4 per cent. Gauges of lengths up to 10 mm., and exceeding 10 mm., have finished cross-sectional dimensions of 9 by 30 mm. (0·35 by 1·18 in.) and 9 by 35 mm. (0·35 by 1·38 in.), respectively, and they are made from ground-finish steel bars having dimensions approximately 0·3 to 0·4 mm. (0·012 to 0·016 in.) greater than the final sizes. The bars are cut into lengths on two machines of which the most modern is the type W 250 BA automatic sawing machine shown in Fig. 1.

Supplied by the French firm Etablissements Winter, 12-24 Rue Guilhem, Paris, XI, this machine, which is installed in one of the general machine shops, has a capacity for cutting up to four thicknesses of the ground stock at once. The lengths of stock are held together with their wider faces vertical by means of toolmakers' clamps so that they may conveniently be treated as a single bar, and are supported on a flat surface at the top of a pedestal which carries the stock feed air cylinder *A*, and by the lower surface of an air cylinder-operated vice at the sawing position. The fixed jaw is integral with the vice and the sliding jaw is attached to the cylinder ram, both jaws being designed to apply clamping force at each side of the sawing position. A vertical slot in each jaw provides for the passage of the saw during the cutting operation.

The ram of the feed cylinder *A* is connected to a slide supported on a bracket fixed to one side of the machine bed, and this slide carries a second air-operated vice, the jaws of which also embrace the stock. Movement of this slide is limited by an adjustable stop, which can be clamped in any position on the dovetail ways, to set the length of material to be fed. The feeding operation is performed automatically, on withdrawal of the saw, under the control of solenoid valves in the sheet metal cabinet at the left. These valves are operated by limit switches actuated at the ends of the air cylinder strokes, and the sequence is so arranged that the main vice is released as the second set of jaws is tightened.

The feed cylinder *A* is then operated, to move the stock forward by the required amount, after which the vice is tightened and the sawing operation starts. During sawing, the second set of jaws is released and the feed slide retracted, in readiness for the next feeding movement. Within the vice jaws there is a limit switch, the plunger of which must be depressed by the stock as the vice is closed, to initiate the movement of the sawing head. When no more stock remains, closing of the jaws fails to operate the switch, and the machine then stops automatically.

Sawing is performed by a 6-in. diameter blade on the end of a horizontal spindle which is driven

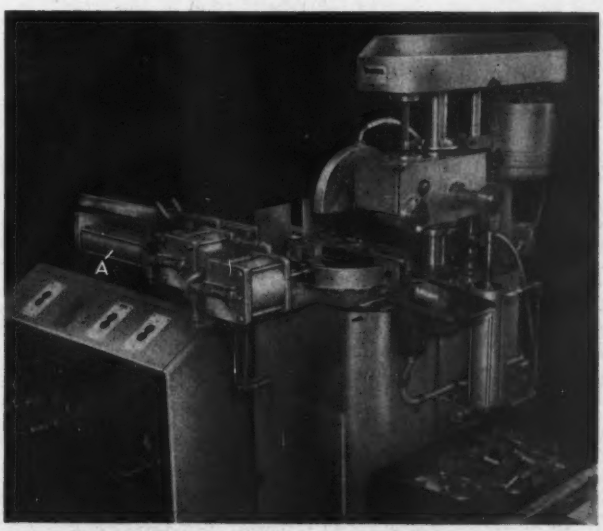


Fig. 1. Stock is cut into blanks for slip gauges on this French-built automatic sawing machine, which is operated by means of air cylinders, and cuts through four pieces of stock in 3 min.

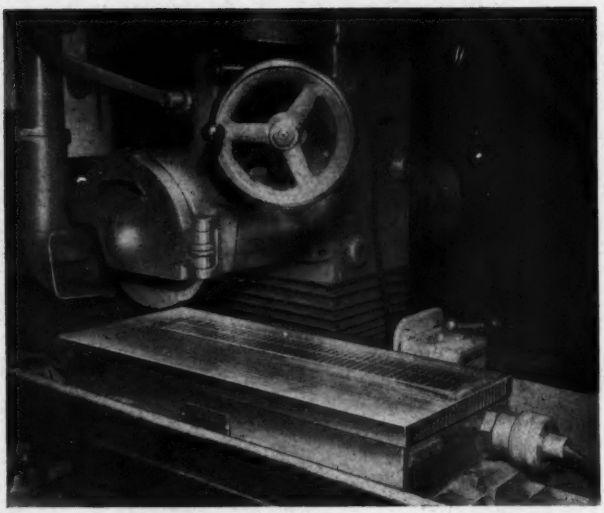


Fig. 2. Heat-treated blanks are ground all over on a battery of surface grinding machines fitted with electro-magnetic chucks having the pole pieces closely-spaced to provide high gripping power

at one of four speeds from a motor at the rear, through V-belts, the highest speed available (68 r.p.m.) being used. The drive is taken through a vertical splined shaft and bevel gears to permit movement of the head on its column, under the control of the vertical air cylinder at the right. A hydraulic check cylinder, mounted in tandem with the air cylinder, controls the rate of feed of the saw, and it is set to cut through the four thicknesses of stock in about 3 min. Stock is cut to a size which leaves some 0·4 to 0·6 mm. (0·015 to 0·024 in.) on the overall length of each piece, and the machine is capable of repeating the set length within 0·1 mm. (0·004 in.), and of producing accurately square faces.

HEAT TREATMENT AND GRINDING

From the sawing machine the pieces are transferred to the heat-treatment department where they are hardened to Rockwell 65 C. In accordance with the practice of most makers of slip gauges today, the Zeiss heat treatment is designed to produce dimensional stability, some small sacrifice in hardness being made to this end. The gauges are first heated evenly to 900 deg. C., and quenched in oil for hardening. An artificial ageing treatment follows which involves holding the blanks at 120 deg. C. for a period of 90 hours, and then at −90 deg. C. for 8 hours. Sample blanks from each batch are tested for hardness, and a thorough check is made at a later stage to ensure that the gauges are dimensionally stable before they are finally made up into sets.

After heat treatment has been completed, the blanks are passed to the slip gauge production shops, which form part of the main Zeiss works. This department provides employment for some 35 people, and is also responsible for the production of 3-wire measuring sets, and for lapping operations on components for other Zeiss measuring instruments. At the first operation, the hardened blanks are surface ground, on a battery of four machines made in East and West Germany. A typical set-up is seen in Fig. 2, on a machine built by Elbe-Werke-Dresden, the blanks being held on an electro-magnetic chuck, made by E. Herrnberger, Schonau.

The chuck has closely-spaced, longitudinal pole pieces to provide a maximum concentration of magnetic flux and thus ensure that the blanks are held securely in position, and it operates on a supply voltage of 220, with a consumption of 0·48 amp. Thin blanks, such as those shown, are positioned transversely, and ground on both measuring faces, about 0·07 mm. (0·0028 in.) being left on the overall length. The side faces are subsequently ground with the aid of angle blocks, to ensure squareness, to within 0·07 mm. of the finished sizes specified earlier. Longer gauges are ground first on the side faces, after which the measuring faces are ground to provide the same finishing allowance. The blanks are subsequently thoroughly demagnetized before they are transferred to the first of a series of lapping rooms for the preliminary lapping operation.

PRELIMINARY LAPPING

All the rooms employed for lapping operations on slip gauges and other highly accurate measuring machine parts at the Zeiss works are fully air conditioned, to enable the temperature and humidity to be controlled within very close limits. A view inside one of the rooms is given in Fig. 3, and each houses two or four of the special machines shown, according to the amount of material to be removed at successive lapping stages. High-

Fig. 3. This view inside one of the air-conditioned lapping rooms at the Zeiss works shows examples of the machines employed. A cover prevents atmospheric dust falling on the laps

magnification comparators, made by Zeiss specifically for slip gauge work, are provided so that the gauge dimensions can be accurately checked as the work proceeds. Large, easily-read, thermometers and humidity indicators are installed in each room, and a constant check on the atmospheric conditions can thus be maintained by the operators.

In the room employed for preliminary lapping, the temperature is held at slightly less than 20 deg. C. (68 deg. F.), to compensate for the heat generated in the slip gauges by the operation. Details of a typical machine, of Zeiss design, may be observed in Fig. 4, and similar machines are employed for all the lapping stages on slip gauges.

Of cast iron construction, the machine has a circular base with an extension bracket at floor level to carry the driving motor. From this motor the drive is transmitted through V-belts and a steplessly-variable P.I.V. unit to a large-diameter spur gear within the circular base.

Part of this gear is visible at *B*, and it meshes with pinions on four equally-spaced vertical shafts which are mounted in bearing brackets on the inside of the base casting. The upper ends of these shafts carry eccentric pinions, and when the shafts are rotated the pinions follow circular paths. The teeth of these eccentric pinions are engaged with internal teeth on a steel ring which supports the work-carrier plate, and their motion is transmitted to the plate so that it is caused to rotate with an eccentric motion.

Beneath the work-carrier plate there is a spindle carrying the lower lapping plate, which is normally stationary during lapping operations,

Fig. 4. Further details of the design of the Zeiss slip gauge lapping machines can be seen in this view. Both laps remain stationary and the blanks are oscillated between them

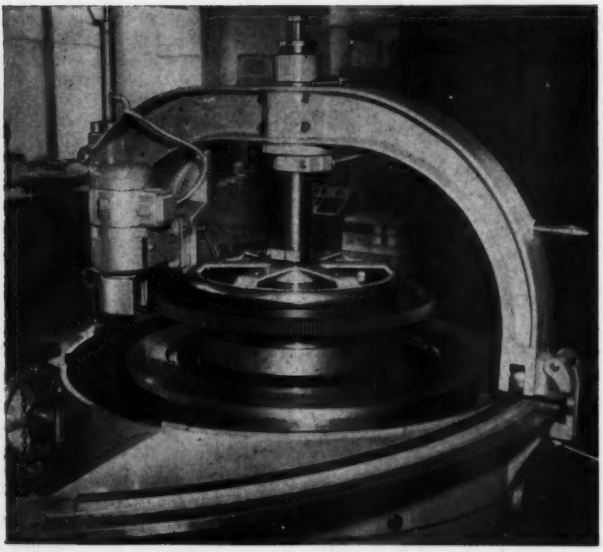


Fig. 5. For conditioning laps, certain of the machines are fitted with driving equipment for the upper laps. A pinion on a motor shaft meshes with a gear on the upper lap holder

but can be rotated, if required by means of the handwheel *C*. This handwheel drives a lower shaft by roller chain, and the shaft is connected to the spindle through bevel gears. The purpose of this arrangement will be explained later. A curved girder-section arm, supported by a heavy vertical post at the side of the machine bed, carries the upper lap, which is also stationary during lapping operations. The arm has a slot at the end opposite to the post with a wheel whereby its weight is supported when it is swung aside for loading or removing the workpieces.

This wheel runs along a track provided on a bracket at the side of the base, and the arm has a quick-acting clamp whereby the outer end can be rapidly secured to the base when lapping is to take place. A screw which carries the upper lap is engaged with a threaded bush in the centre of the arm casting. Equipment is fitted to the machine for counting the number of rotations of the work-carrier plate. A predetermined number of eccentric motions, based on experience and on the amount of material to be removed, is set on a dial, and the machine is started by a rotary switch. When the required number of rotations has been completed, the machine is stopped automatically.

The laps employed in the Zeiss plant are made from special close-grained cast iron, and with an outside diameter of 18 in. and a thickness of 3 in., and each weighs about 165 lb. There are three laps in a set, so that they can be used to condition one another, and certain of the machines are adapted for this work, an example being shown in Fig. 5. Here it will be seen that the mounting plate for the upper lap is fitted with a large-diameter ring gear. At the mounting-post end, the curved arm has a bracket, held in place by screws and dowels, on which there is a sliding mounting for a small electric motor with a pinion on the lower end of the vertical shaft. The motor can be adjusted sideways to bring the teeth of the pinion into mesh with those of

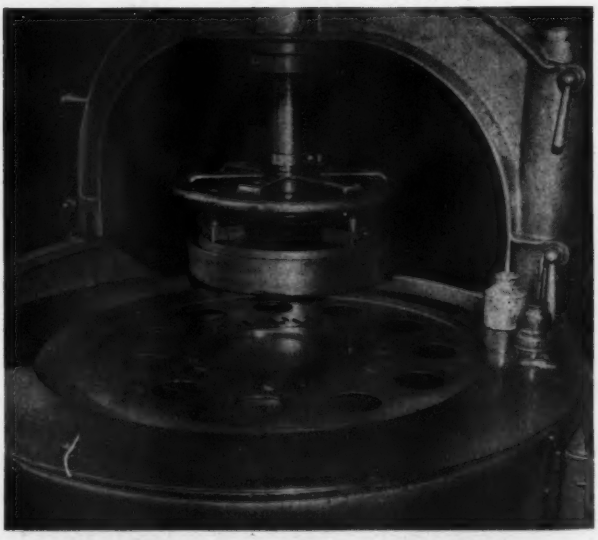


Fig. 6. Work-carrier plates for thin gauges have 22 apertures, each of a diameter large enough to take two blanks at a time. Lightening holes in the plate help to ensure that it does not sag into contact with the lap

the ring gear, so that the upper lap can be driven when required.

For the preliminary operations on the blanks, the laps are charged with a compound of fine emery, obtained by suspension grading, with a mixture of oil and petrol. This mixture is applied to the lap surfaces with a lint-free cloth, using a circular scrubbing action, and the surplus is wiped off until the lap surfaces look almost as clean as before. For thin blanks, work-carrier plates having 22 apertures, each large enough to hold two blanks, are employed, as seen in Fig. 6, which is a view of the machine in Fig 4 from the opposite side. The plate also has a series of lightening holes which reduce the weight so that it does not sag on to the lower lap surface.

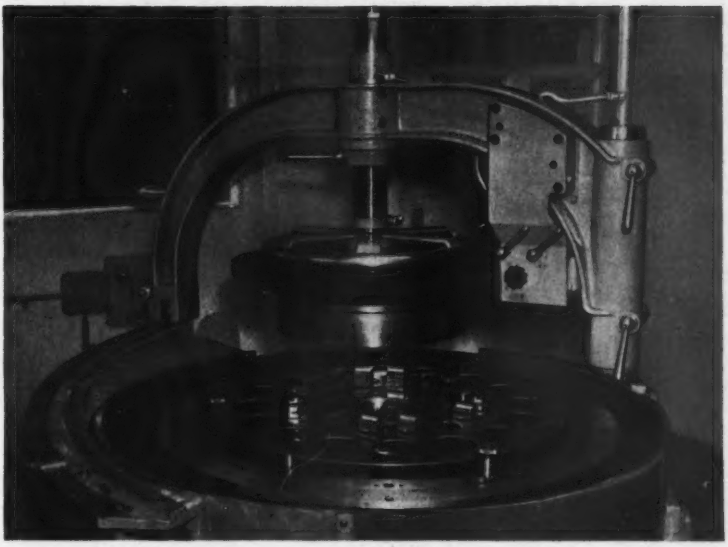


Fig. 7. For longer slip gauges, work-carrier plates have larger apertures in which 16 blanks are supported with the aid of extra steel blocks, held in place by elastic bands, to prevent tipping

Longer blanks, which have a tendency to tip sideways when the direction of movement is normal to the wider side faces, are held in carrier plates with slightly larger apertures, as seen in Fig. 7. To each wider side of each blank is fastened a thickening piece. These pieces are slightly shorter than the blank, and are held in place by wide elastic bands. The combined section of the thickening pieces and the blank is almost square section, and greater stability is thus ensured, with less tendency to tip. A period of about 6 to 7 hours is normally required for the preliminary operations, during which lapping is carried out initially with the machine set to stop after 400 oscillations.

As the work proceeds, the blanks are changed around in the apertures in order to equalize the action and bring each to the same overall length within 0·003 mm. (0·00012 in.) of the nominal dimension, for slip gauges up to 10 mm. (0·39 in.). A slightly larger allowance is provided on the longer blanks which tend to retain heat longer. Dimensional checks are performed on Zeiss Optimeter comparators, after the blanks have been cleaned with petrol to remove abrasive, and further lapping compound is added as required. As the length of the blanks approaches the required value, the number of oscillations at each stage is reduced by the operator, and the blanks are finally cleaned and packed into trays for return to another room, next to the surface-grinding shop, where marking operations are carried out.

MARKING AND CHAMFERING OPERATIONS

Marking of the nominal size, grade of accuracy, Zeiss trade mark, and code number, is carried out by etching. A thick line of molten wax is first painted round the area to be marked, after which the area is covered with a thin film of wax which is retained by the thick line. The required symbols are then engraved in the wax on the special Zeiss-built engraving machine shown in Fig. 8, which has a capacity for engraving 12 gauges at a time. Gauge blocks are positioned by surfaces at 90 deg. on the top face of a slide, which has compound adjustment to provide for positioning the symbols.

Behind and above the slide there is a long T-slotted bar to which are fixed hinged carriers for the gramophone needles employed for engraving. Each holder is attached by a thread to one of 12 wires secured to a bar which can be rotated by a lever, seen under the left thumb of the operator. This lever serves to lower the

Fig. 8. Length, trade mark and code number are engraved in wax applied to slip gauge surfaces, on this Zeiss-built machine, on which 12 blanks can be accommodated simultaneously

needles simultaneously into the wax and to raise them after a symbol has been engraved. Engraving is carried out by imparting movement to the T-slotted bar carrying the needles, which is supported on compound ball-bearing slideways. The slides are connected to a vertical lever, held in the operator's right hand, which is hinged near its upper end, so that movements of the lower end are reduced in the ratio of 5:1 at the needle points.

Beneath the lower end of the lever there is a stage to carry the template, and the lever has a lightly spring-retracted point which can be pulled down to enter the template groove when engraving is to be performed. Etching is performed with a solution of potassium nitrate to a depth of 0·03/0·04 mm. (0·0012/0·0016 in.), in a period of 4 to 5 min., after which the acid is neutralized with a 5 per cent soda solution and the wax is removed by heating.

Edge-bevelling is then carried out on the small grinding machine shown in Fig. 9, three of which are installed in the surface grinding room. The wheel spindle is driven through V-belts by the small motor at the left, and the base-plate carries a post *D*. At the top of this post there are guideways for a horizontal slide which can be traversed by a screw turned by the small handwheel at the left-hand end. The right-hand end of the slide carries a diamond which is thus moved across the side face of the grinding wheel. In front of the wheel face thus dressed, a steel plate is arranged at an angle of 45 deg., and the upper edge has brackets at each end to carry a steel strip.

There is an aperture between the edge of the plate and the steel strip, such that when a slip gauge is pushed against the strip, the corner projects on the far side. The distance from the plate to the grinding wheel is so arranged that the wheel grinds away the corner, at an angle of 45 deg., for the required distance of 0·2 mm. (0·0079 in.). All the edges of the blanks are thus treated very rapidly.

FINISH-LAPPING OPERATIONS

Bevelled blanks are subsequently returned to the lapping rooms where they are brought to the nominal dimensions within the limits laid down in the DIN specification mentioned earlier. These finishing operations are performed on machines of similar design to those discussed above, with corresponding position-changing sequences for the blanks in the work-carrier holes. The laps employed are subjected to a special heat treatment process which produces extremely hard iron phosphides in the matrix and causes the ferrite particles to break down slightly, leaving these phosphides embedded in the lap surface. With such laps, no abrasive is required, and only petrol is applied to clean the various surfaces when the slip gauges are changed round in the apertures.

The first lapping operation is carried out with short periods of oscillation, starting with as few as 12 turns before a measurement is made. For long gauges, such as those shown in Fig. 7, the mechanism provided for turning the lower lap is employed to bring the sides of the blocks into contact with the edges of the apertures in the work-holding plates before the upper lap is moved into position and the machine is started. It is thus ensured that the gauges do not tip when the work-carrier motion is started. Lapping is continued until the blanks are within 0·0008/0·0009 mm. (0·000031/0·000035 in.) of the nominal dimension.

For the final lapping operation, the slip gauges are transferred in trays lined with lint-free cloth to the room seen in Fig. 3, where the temperature is controlled within ±0·5 deg. C. Several hours are

allowed to elapse and further work is performed to ensure that the temperature of the gauges is in equilibrium, and they are then subjected to combined sizing and polishing operations. Up to this stage, all lapping operations are performed solely under the weight of the upper lap, the screw being employed only for lowering and raising. On the finishing machines, however, each upper lap is attached to the handwheel disc by means of three equally-spaced studs, which are a loose fit in holes in the disc.

Surrounding each stud there is a coil spring, and when the lap has been lowered, to rest on the gauges, further turns of the handwheel compress these springs to apply pressure to the lap. This pressure serves to increase the almost non-existent cutting action of the lap to the point at which extremely small amounts of material are removed, and the gauges are thus slowly reduced in length until they exceed the nominal dimension by about 0·0002 mm. (0·000008 in.) for sizes up to 50 mm. long, and slightly more for longer blocks. The spring pressure is subsequently released and lapping continued to polish the measuring faces, with only very slight material removal.

Zeiss slip gauges are normally produced to dimensions within the plus portion of the tolerance, to permit the maximum amount for wear before rectification is required, and thus ensure service life. As regards the finish of the measuring faces, the DIN specification makes no specific provision except that there must be "spontaneous adhesion" of two faces without the application of pressure. It is stated by the Zeiss organization that experience has shown that when gauges having a mirror finish are wrung together in a grease-free condition, the intimate contact between the faces results in local cold welding.

Such welding may result in damage to the faces when they are subsequently separated, with the result that the accuracy of the slip gauges may be affected. To prevent such damage, the surface finish of Zeiss slip gauges is deliberately held at 0·00003/0·00004 mm. (1·2/1·6 micro-inches). Such a surface, it is claimed, will retain sufficient lubricant in the hollows to prevent cold welding during wringing.

INSPECTION AND GRADING

After the completion of the final lapping operations, during which frequent measurements are made of the lengths of the slip gauges at several positions on the faces, the finished gauges are passed to the temperature—and humidity—controlled room shown in the heading illustration. Since the Zeiss organization also functions as a Government testing laboratory, with interference equipment for the absolute measurement of the lengths of slip gauges, approved standards are readily available with which the gauges produced can be compared. Master sets of gauge blocks are provided by the laboratory, which is situated in another part of the building, for setting comparators, and these masters are returned to the laboratory for checking from time to time.

In the inspection room shown in the heading illustration, Zeiss comparator equipment of various designs is employed, but most of the instruments operate on a similar principle. A close-up view of one of the latest of these instruments is given in Fig. 10. Known as an opto-mechanical projection indicator, the instrument is capable of detecting

Fig. 9. The edge chamfers of 45 deg. by 0·2 mm. are ground on the slip gauge blanks on this machine. A support plate is set at the required angle, and a fence controls the amount of metal removed

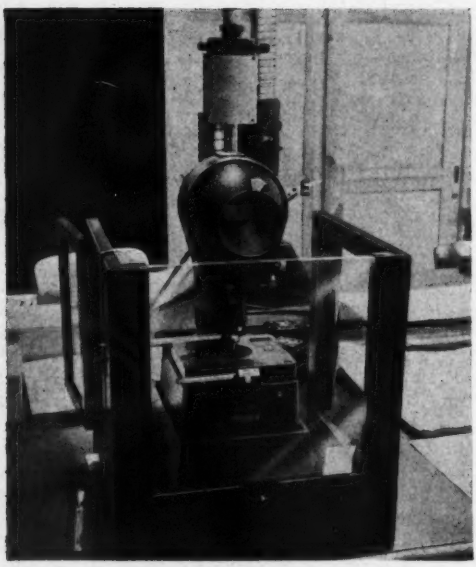


Fig. 10. The latest design of opto-mechanical projection indicating comparator, employed for inspection of slip gauges in the Zeiss works, operates on the auto-collimation principle. Each scale division represents 8 micro-inches

very small differences in dimensions. Measurements are read from an illuminated scale on which each division, with a width of 1·6 mm. (0·063 in.), represents 0·0002 mm. (0·000008 in.).

The instrument operates on the principle of auto-collimation, light being provided by a 6-volt, 30-watt lamp, in a holder, separately mounted above. Light passes through a condenser to an illuminating prism and thence through a reticule on which the scale is marked. The scale image is transmitted by way of an objective lens and a fixed mirror to a pivoted mirror which is connected to the upper end of the measuring plunger. From this pivoted mirror the image is reflected along almost the same path, and is finally transmitted by way of a projection lens and further mirrors on to a ground glass screen within the hood *E*.

The image on the scale is sufficiently bright to be read easily in full daylight with both eyes. There is a lever-type retractor provided with a wooden arm to prevent heat transfer from the operator's fingers, whereby the measuring plunger can be lifted when gauges are being placed in position. A special stage is employed for measuring slip gauges, with five carbide-faced ribs to ensure adequate support. At the front of the stage there is a clip to hold a contact thermometer so that the operator can check the temperature of the instrument if necessary. There is an enclosure with panels of heat-insulating Robon glass to minimize heat transfer from the operator, and the doors have slots through which the gauge blocks and the retractor lever can be manipulated.

When finished slip gauges are first received in the inspection room they are stored for several days to allow the temperature to reach equilibrium. Measurements of the overall length of a gauge, in relation to a master calibrated by the test laboratory are then made at the centre of the measuring face and at each corner in succession. Records are kept of the difference in the length from the nominal dimension, and the gauges are then stored for one month before the procedure is repeated. After a further month, the measuring sequence is again carried out, and only those blocks which show no measurable change are passed for sale. As mentioned earlier, certain slip gauges which are closer to the nominal dimensions than is required for the grade 0 specification are passed to the test house for approval for grade 00, of which a few sets are produced each year.

ALLAN RUST PREVENTIVES. The following range of rust preventives is being marketed by K. Allan & Co., Ltd., Alanzol Refinery, Bream, nr. Lydney, Glos., who have been making technical lanolin for some years, and blend and formulate a range of petroleum-based products. In this connection it is pointed out that effective, long-period protection against rusting is afforded by a thin film of lanolin, which is weather resisting, adheres well to metal, and, when mixed with suitable solvents, wets the surfaces effectively.

Kalub AR. 20 rust-preventive engine oil (SAE 20) can be used for engine storage or for initial lubrication of engines.

Kalco dipping oil No. 3 possesses de-watering properties. It can be sprayed on to surfaces or applied by immersion.

Kalco dipping oils No. 2 and 1 also have de-watering properties and progressively lower viscosities as compared with No. 3.

Kalco rust preventives No. 4 and 5 may be applied by brush, swab, spray, or dipping, and form hard protective films on metal parts.

Alanzol rust preventive No. 6 is applied hot and forms a plastic film which provides, for example, for the protection of tool tips.

Other products of the company include vapour phase inhibitors for special purposes such as the protection of camera parts and instruments.

Sciaky Automatic Multiple-spot Welder for Metal Strip

Sciaky Electric Welding Machines, Ltd., Falmouth Road (Trading Estate), Slough, Bucks., have built the fully-automatic, travelling-head, multiple-spot welding machine shown in Fig. 1 for use in conjunction with a continuous strip mill. Designated type SOM 200, this machine is intended to be installed between the strip rolling mill and an annealing furnace, and provides for spot welding the trailing end of strip in one coil to the leading end of another coil, to form a continuous length.

Metal strip from the mill is passed over support rolls between the central and left-hand columns at the front and rear of the fabricated steel frame, and is guided by side rollers. When two lengths of strip are to be joined, their ends are cut square, and are then positioned between the front and rear support rolls so that they overlap. The lengths of strip are now held in contact with each other under pressure at the ends of the overlap portion, by downward-acting hydraulic clamps.

At the right-hand end of the machine, there is a substantial C-shaped frame which carries four pairs of upper and lower welding heads as may be seen in the close-up view in Fig. 2. This frame is now advanced to the left, on roller guideways between the front and rear columns, by a screw which is driven by a 3-h.p. motor through an air-operated clutch. At a predetermined point in the travel of the frame, the clutch is disengaged to stop the drive, and the upper and lower heads are then advanced hydraulically towards each other, for spot welding the strip at four points close to the right-hand edge. When the heads have been brought clear of the strip, the C-shaped frame is moved further to the left, in steps, and at the end of each movement, welding is carried out on the strip. During the individual welding operations a maximum force of 5,000 lb. can be applied to the strip by the electrodes, and the distances between the rows of welds are controlled by adjustable cams mounted on the side of the C-shaped frame. After the heads have been brought clear at the end of the last welding operation, the frame is returned to its starting position, and the clamps are released.

The machine has a capacity for spot welding hot- or cold-rolled silicon steel strip up to 42 in. wide, in two thicknesses up to 0·1 in. During the welding cycle, which may occupy a period up to 2 min., depending upon the width, strip is drawn from a loop at the rear of the machine, so that it continues to be fed through the annealing furnace without interruption. It is stated that the strength of the welds is such that tensile stresses up to 1,000 lb. per sq. in. can be applied to the strip while it is being passed through an oil-fired or electric annealing furnace with a working temperature of 913 deg. C., also pickling, and side trimming plant, for example.

Electrode current is taken from two 100-kVA.

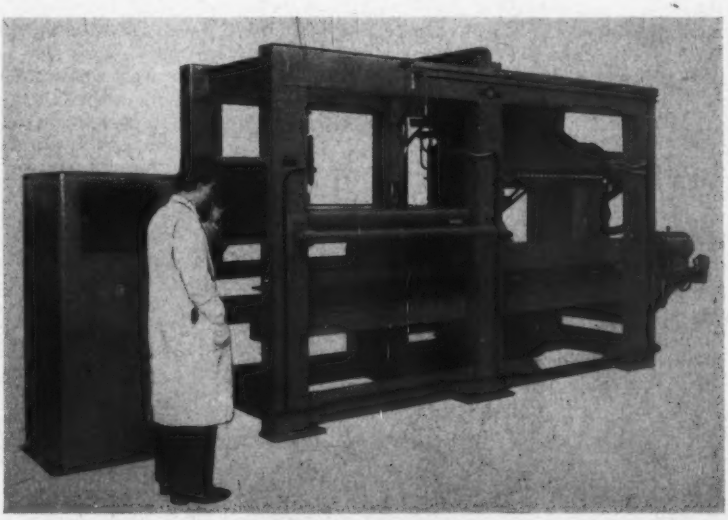


Fig. 1. Sciaky automatic multiple-spot welder for metal strip

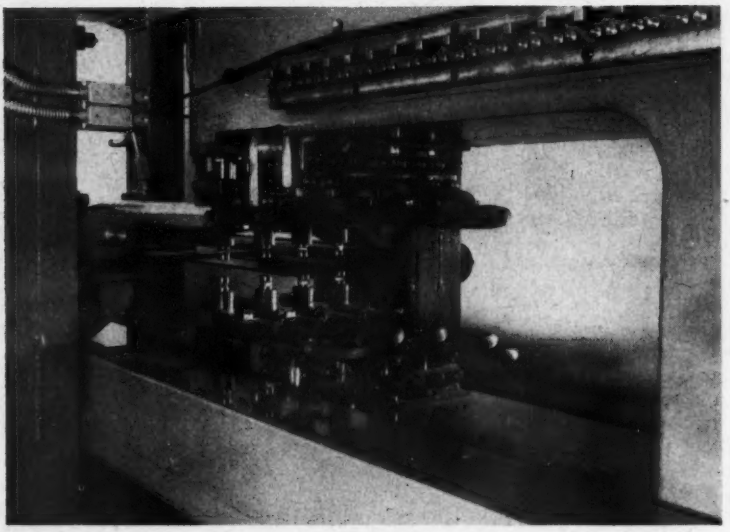


Fig. 2. Close-up view of the welding heads on the Sciaky machine

transformers with "push-pull" type secondary windings, which are claimed to reduce power losses. The Sciaky thyratron timer for controlling the welding cycle, also equipment for phase-shift heat control, and ignitron contactors, are housed in a separate floor-mounted unit. Push-buttons for controlling the various motions by hand, and for starting the automatic cycle, are conveniently grouped on a panel mounted on the left-hand column.

The equipment can be controlled by the Sciaky 3-phase balanced-load system, with a minimum power factor of 0·85, for welding widely different metals and thicknesses, including light alloy materials.

Wavis Unit Heads and Indexing Tables

UNIT HEADS OF TWO DESIGNS are included in the range of equipment built by Wavis Engineering Development Co., Ltd., Highlands Road, Shirley, Warwickshire, and the quill-type drilling head seen in Fig. 1 is available in two sizes, which are known as M.1 and M.2 and may be provided with motors up to ¾ and 2 h.p. The maximum working travel is normally 4½ and 6 in., for the two sizes, and motion is imparted positively to the quill, in a cycle comprising rapid approach, feed, and rapid return, by means of a screw and nut. The unit is claimed to be particularly suitable for rapid operation, and to permit tapping to be performed, the screw and nut may have a lead identical to that of the thread to be cut. The standard range of spindle speeds is from 265 to 4,500 r.p.m., and feed rates from 0·0005 in. per rev. and rapid traverse rates up to 200 in. per min. can be provided.

Designated T.1, the smallest size in the range of slide-type unit drilling and milling heads may be

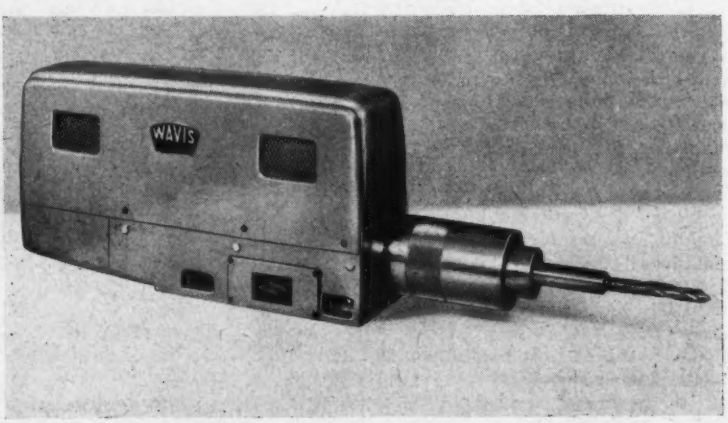


Fig. 1. Wavis quill-type unit drilling head

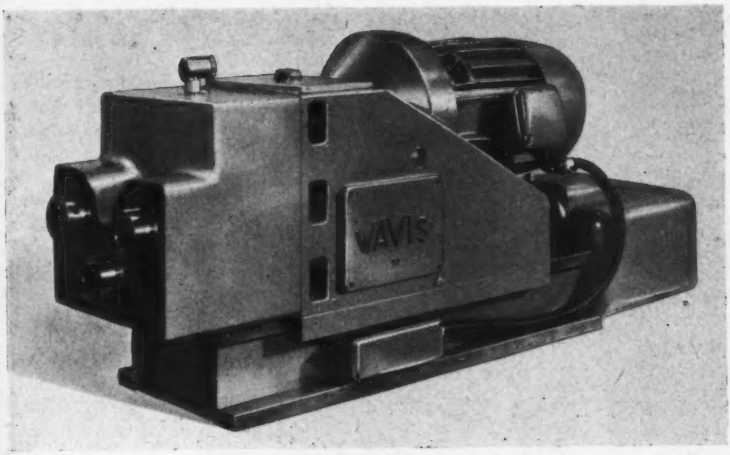


Fig. 2. Designated T.2, the intermediate size from the Wavis range of unit heads is here shown with a multi-spindle attachment

equipped with a motor of ¾, 1, 1¼, or 1½ h.p. for the spindle drive, and has capacity for drilling single holes up to ⅛ in. diameter in steel with a tensile strength of 50 tons per sq. in., and 1¼ in. diameter in cast iron. The maximum working travel is normally 10 in. A driving motor of 2, 3, or 5 h.p. can be provided for the type T.2, which has capacity for drilling single holes up to 1¾ and 2½ in. diameter in steel and cast iron, and the type T.3, which is the largest size in the range and provides for drilling up to 3¼ in. diameter in steel, may have a motor of 7½, 10, 12½ or 15 h.p. The spindle nose can be arranged to take a Morse taper shank or may be of the standard milling machine type. Alternatively, provision can be made for driving a multi-spindle attachment, of which a variety is made by the company. In use, such an attachment is mounted on the machined front face, as shown in Fig. 2, where a 3-spindle unit is seen mounted on a head of the intermediate size.

Units can be supplied for clockwise or anti-clockwise spindle rotation, and speeds and feeds are normally obtained individually by means of separate sets of pick-off gears. According to the size of the unit, the speeds available range from 120 to 4,250, 89 to 2,500, and 45 to 1,000 r.p.m., and there is a total of 70 feed rates, in two ranges, from 0·0014 to 0·0685 in. per rev. for the smallest head, and from 0·0019 to 0·088 in. per rev. for the larger sizes. Feed drive is taken from the transmission to the spindle, through worm gearing, to a nut which rotates on a stationary screw. For rapid traverse, at the rate of 150 in. per min., this screw is driven by a separate motor, and a disc brake prevents rotation during feed movement. The gears and the bearings in the transmission systems run in oil baths, and lubrication is provided automatically for the traversing nut and the ways on which the head slides.

Rapid approach, feed, and rapid return movements can be applied in various cycles, for drilling, tapping, spot-facing, and interrupted cutting. Movements are controlled by three limit switches, which are housed in a box that may be mounted on either side of the base. These switches are operated by means of plungers, which extend across the base and are engaged by adjustable dogs on a bar that is attached to the opposite side of the head. For use when counterboring or spot-facing, for ex-

Fig. 3. A 24-in. diameter automatic indexing table is here seen mounted on a stand, for testing

Fig. 4. Typical of the special-purpose equipment which is designed and built by the company, this 8-station machine provides for various operations on a cast iron workpiece, in a cycle time of 16 sec.

ample, a unit can be mounted at the end of the base, for positively limiting the feed movement, and it may be employed in conjunction with an electric timer, to cause the head to dwell before it is rapidly returned. If desired, provision can be made for step-by-step feed motion for deep drilling.

These units are so designed that the principal items subject to wear are arranged as assemblies, such as the spindle drive transmission, which can be detached without the need for dismantling. To enable a unit to be mounted vertically, provision is made for the attachment of two chains, for connection to a counterbalance weight.

The range of indexing tables built by the company comprises five sizes, with diameters from 12 to 48 in., which can be supplied for automatic or hand operation, and in Fig. 3 a 24-in. diameter table, of the automatic type, is seen mounted on a temporary stand, for testing purposes. With these units, indexing motions are applied by means of a modified Geneva mechanism, and after completion of each movement, the table is clamped at the periphery. All the working parts of a table are pressure-lubricated by means of a built-in pump.

SPECIAL 8-STATION ROTARY MACHINE

In addition, the company has facilities for designing and constructing special-purpose machines incorporating standard items from the ranges, and an example is seen in Fig. 4. Of the rotary indexing type, this 8-station machine provides for drilling, reaming, spot-facing, and tapping operations on a cast iron workpiece, also for cutting a cone seating, and it incorporates a total of eight type T.1 unit heads, equipped with 1½-h.p. motors, and one type T.2 head, with a 5-h.p. motor. Multi-spindle heads mounted on all these units are of designs which differ slightly from standard, and on one head, which is employed for drilling small-diameter holes, there is an automatic sensing arrangement. In the event of a drill being broken, the machine is stopped before starting the next cycle, and further operation is prevented until a fresh drill has been fitted. Eight work-holding fixtures are carried on a standard 36-in. table, and the cycle time is 16 sec.

SPEEDICUT VANLEDA HIGH-SPEED STEEL.—Thos. Firth & John Brown, Ltd., P.O. Box 114, Atlas Works, Sheffield, 4, have recently introduced an improved high-speed steel known as Speedicut Vanleda, which contains 5 per cent of vanadium and cobalt. A high proportion of the vanadium content is in the form of vanadium carbide, which confers good abrasion resistance, with little or no loss of toughness.

Speedicut Vanleda steel has been found advantageous when sintered carbide tool materials cannot be used, and good results have been obtained when machining difficult materials such as heat resisting steels and alloys. Improved cutting has been obtained when the new steel has been used for operations on low alloy steels and chilled iron. The new steel can be used for turning, milling, drilling, boring and shaping operations, and is stated to give longer tool life with increased output between regrinds, as compared with 18 per cent tungsten or cobalt high-speed steel. It is claimed that higher speeds and increased feeds can be employed, and the improved wear resistance facilitates the maintenance of accuracy, form, and surface finish.

Use of a Transistor Phase Meter for Torque Measurement

PRIMARILY INTENDED FOR MEASURING phase shift in electrical networks and turned circuits, the type 630 transistor phase meter, which has been introduced recently by Dawe Instruments, Ltd., Western Avenue, London, W.3, and is shown in Fig. 1, can also be employed for comparing the phase of two signals. A method has been developed by the company, whereby advantage is taken of this facility for checking the angular relationship of two axially-spaced points on the periphery of a rotating component, and the difference is indicated on a dial which is graduated in deg. The angle through which the part is twisted under a dynamic load can thus be obtained, and the torque may then readily be calculated.

Signals can be obtained from separate transducers of any type, which have outputs between 0·03 and 300 volts, r.m.s., and when the rotating part is enclosed, for example, an electromagnetic detecting system can be employed. With such a system, small magnets, secured to the periphery, induce pulses in pick-up heads mounted outside the casing. When access to the member under investigation is not obstructed, photo-electric cells can be employed for detecting the passage of marks on the periphery, and in the typical set-up shown in Fig. 2, which is used by Humber, Ltd., for simultaneously endurance testing two gearboxes, two Dawe type 716 phototransistor pick-up units are seen arranged for operation in conjunction with strips of white adhesive tape applied axially on the connecting shaft. The

Fig. 1. Dawe type 630 transistor phase meter

Fig. 2. In this set-up, employed by Humber, Ltd., for simultaneously endurance testing two gearboxes, the phase meter shown in Fig. 1 is seen connected to two type 716 phototransistor pick-up units, for measuring torsional deflection of the connecting shaft

remaining portion of the shaft surface adjacent to each unit is covered by black tape, to prevent random reflection, and from the torsional deflection thus measured, the torque in the entire system can be determined. For ascertaining the torsional deflection of drills and reamers, for example, under various cutting conditions, the units may be employed in conjunction with discs, which are mounted on the tools. Half the upper surface of each disc is covered by white tape, and the remaining area is black.

The type 630 phase meter has a frequency range from 1 c.s. to 25 k.c.s., which is equivalent to 60 to 1,500,000 r.p.m. when pulses are received at the rate of one per rev., but the lower limit can be extended by providing for several pulses per rev. With balanced signals, the guaranteed accuracy at frequencies higher than 10 cycles per sec. is ± 3 deg., and it is stated that an accuracy within 1 deg. is often obtained. The instrument can be operated from a mains electrical supply or from internal batteries, and including the latter, it weighs slightly more than 7 lb., and measures 6⅝ by 7⅞ by 10 in. high.

Large Battery of Esco Coil-fed Automatics

A large battery of Escomatic coil-fed automatics has recently been supplied to a light engineering factory in the London area by Hahn & Kolb (Gt. Britain), Ltd., 243 Horn Lane, Acton, London, W.3, who are the selling agents for these machines in this country. It is claimed that this battery of Esco machines is the largest single group of automatics of this type in the country, and a general view of the complete installation, from one end, is given in Fig. 1.

The group comprises 18 type D.4 machines, seen in the foreground of the illustration, four type DS.2, and five type D.6 machines (the number of the latter will shortly be increased to six). These machines are used for the production of pins, studs, rivets, collars, pillars and similar components, and from the 27 at present installed an output of 2-million parts is obtained per week (of five days, one shift per day).

All three Esco machines have been described in MACHINERY, and it suffices here to say that the DS.2 automatic, with a maximum capacity of $\frac{5}{32}$ in. diameter, has a rotating tool head, with two adjustable tool holders. One tool is used principally for parting off, and the other for longitudinal turning and forming. The work material, which does not rotate, is supported in a bush in the tool head, also in a counter-collet in front of the tools, so that the components can be parted off free from pips and burrs.

The type D.4 machine is also of $\frac{5}{32}$ in. capacity, and has a 3-station end-working attachment, in addition to the rotating tool head. There are two driven spindles in the end-working attachment, which provide for drilling and similar work, also a counter-collet to support the work.

A rotating tool head, with three independently adjustable tool holders, and an end-working

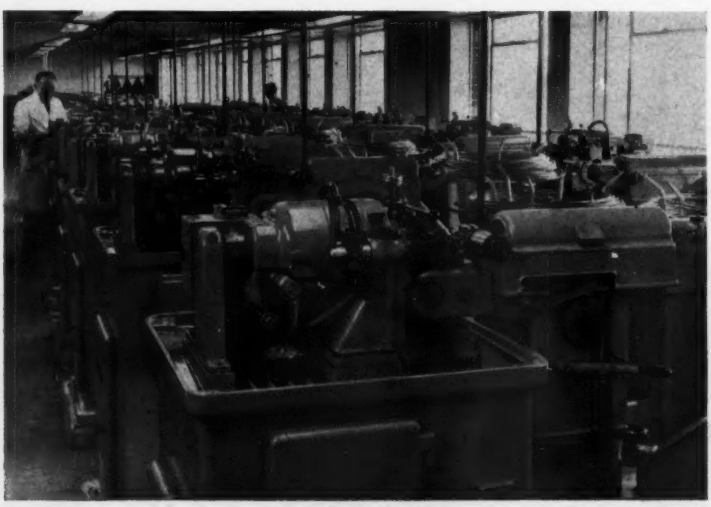


Fig. 1. View of a battery of Escomatic coil-fed automatics in a large light engineering factory in the London area. Type D.4 machines, of which there are 18, are seen in the foreground, and in addition there are five type D.6, and four type DS.2 machines

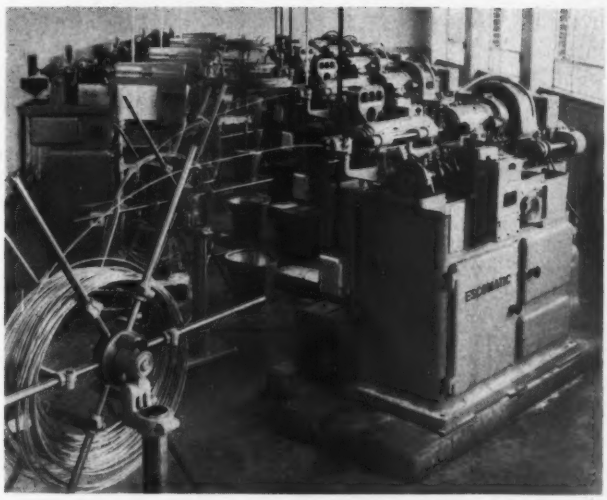


Fig. 2. Type D.6 Escomatic machines are seen at the right, and the type DS.2. machines at the left. These machines are part of a battery of 27 coil-fed automatics, with an output of 2-million components per 5-shift week

attachment with a counter-collet, two drilling spindles and a threading (or third drilling) spindle, are provided on the type D.6 machine, which is the latest and largest in the range. Machines of this type are seen at the right in Fig. 2, which shows the portion of the shop in the background in Fig. 1. At the left, to the rear, may be seen the DS.2 machines.

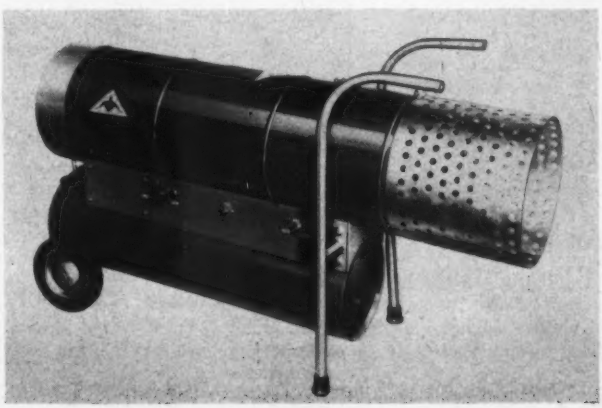
Attention is drawn to the neat and compact arrangement of the machines in Fig. 1 and 2, and it may be noted that the complete battery is housed in a room that measures 98 ft. by 16 ft. There are gangways at the ends and along each side to provide access to the machines, and there is a space between the group D.6 automatics and the D.4 machines for a workbench and a tool grinder. The shop is located on the first floor and the area was previously used for offices. The floor has not been reinforced, but each machine is mounted on an individual concrete plinth and with this arrangement the load is spread over the supporting joists.

Silent Glow Type D 40 Oil-burning Space Heater

The latest addition to the Silent Glow range of portable oil-burning space heaters made by Contractors & Industrial Equipment, Ltd., 31 Birmingham Street, Oldbury, Birmingham, is the direct-fired type D 40, shown in the figure. It has an output of 144,000 B.T.U. per hr. for a consumption of 5½ pints of fuel, and the built-in ⅓-h.p. fan unit provides an air flow of 1,100 cu. ft. per min. The fuel tank has a capacity of 13 gal.

Fuel is drawn from the tank by a pump and is forced under pressure through the nozzle of the burner where it is atomized, mixed with a controlled volume of air, and ignited by means of electrodes. A short, soft flame is obtained which passes through a Solar Glow flame filter, and it is claimed that 100 per cent combustion is thus ensured. Fresh air is driven round the combustion chamber by the blower unit, and the clean heated air current can be directed as required.

The company's direct-fired space heaters are available in capacities up to 405,000 B.T.U. per hr.



The Silent Glow type D 40 oil-burning space heater, which is the latest addition to the range made by Contractors & Industrial Equipment, Ltd.

Evaluation of the Effects of Spline Misalignment

By EARLE BUCKINGHAM

The first part of this article, which was published in MACHINERY, 99/853—11/10/61, was concerned with simplified procedures for analyzing and calculating the various effects of misalignments on straight and crowned splines. Tables of comparative data were also provided to show the effects of changing the number of teeth, material hardness, and misalignment angle. Here, the subject of crowned splines is considered.

When the externally splined shaft member is crowned, the contact conditions are changed materially as compared with those for straight splines. The intersection profile of a spline of the crowned member with a concentric cylinder becomes a curved form which engages the generally straight-sided space of the mating member. The contact between them becomes a straight line, from crest to root of the spline, in the plane of rotation of the shaft member. With these conditions, there are three possible load-limiting factors, namely, the torsional strength of the shaft; the beam strength of the splines; and the surface endurance load limit value of the materials for line contact between a straight and a curved surface. For any given application, the lowest of these values is used if failure is to be avoided.

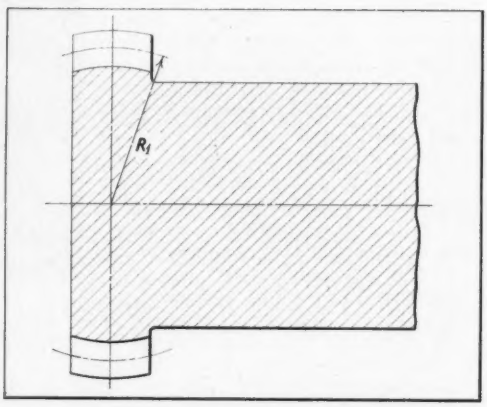


Fig. 6. For the example in this article, the centre of the radius of crowning for crowned splines is assumed to be on the axis of the shaft

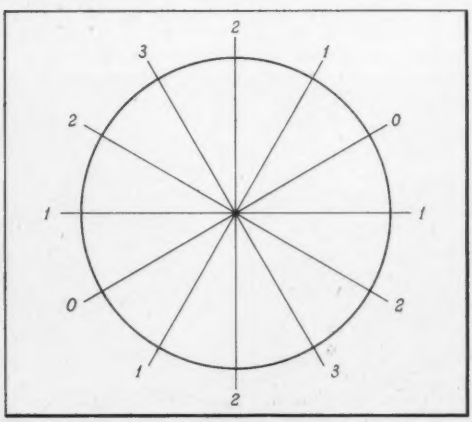


Fig. 5. Method of numbering tooth positions of a 12-spline crowned splined member. Two splines have maximum interference and are numbered 0. Splines adjacent to the 0 position are marked 1, 2, and 3, the No. 3 position representing that of maximum clearance

With the crowned member there are two driving splines in the same plane of rotation of the shaft member at 180 deg. from each other. A special method of numbering the splines is therefore necessary as shown in Fig. 5. The driving splines are numbered 0, and those adjacent to the driving splines are numbered 1, 2, etc., as shown.

The same splines as before will be used as examples. The face width of the spline on the shaft will be equal to one-quarter of the pitch diameter of the spline. The centre of the radius of the crowning will be at the axis of the shaft, as shown in Fig. 6.

POSITIONS OF DRIVING TEETH AND CLEARANCES

For the crowned spline, the equation from which the values of the various clearances is calculated is as follows:

$$-C = R_1 (1 - \cos \Delta) \cos \theta \sin (\theta - \phi) \quad (10)$$

when Δ = angle of misalignment;
ϕ = angle of spline at mid-height (pressure angle of involute spline);
θ = vectorial angle of centre line of tooth, measured from the hinge of misalignment;
R_1 = radius to mid-height of spline, in.
C = clearance between the splines. (When the value of C is minus, there is interference);
C_1 = corrected value of clearance when that on driving spline is zero.

When the values of R_1, Δ and ϕ are fixed, and the values of C and θ are variable, then the value of $(dC/d\theta)$ gives the rate of variation in the value of the clearances. When this value is equal to zero, then the clearance is at a maximum or minimum value.

$$dC/d\theta = R_1 (1 - \cos \Delta) [\cos \theta \cos (\theta - \phi) - \sin \theta \sin (\theta - \phi)]$$

This expression reduces to the following:

$$dC/d\theta = R_1 (1 - \cos \Delta) \cos (2\theta - \phi) \ldots\ldots (11)$$

when

$$dC/d\theta = 0, \cos (2\theta - \phi) = 0$$

and

$(2\theta - \phi) = 90$ deg. and 270 deg.

and when

$\phi = 30$ deg. $2\theta = 120$ and 300 deg.

and

$\theta = 60$ and 150 deg.

One of these last angles is the position of one of the drivers, and the other angle, at 90 deg. from the first, is the position of one of the splines with the maximum clearance.

When the direction of rotation is reversed, the positions of the driving splines will be at the positions of maximum clearance for the original direction of rotation.

Using the foregoing equations, the clearances on the various 2-in. diameter splined members with 8, 16, and 32 splines for different misalignment angles have been calculated and are listed in Table 6. The same misalignment angles as before have been used, and in addition, values for 1·00 and 2·00 deg. have been added.

DETERMINATION OF RADIUS OF CURVATURE OF CROWNED SPLINES

The radius of curvature of the splines of the crowned member in the axial direction must be determined in order to establish the limiting spline load to resist surface fatigue and excessive wear.

TABLE 6. CLEARANCES ON 8-, 16- and 32-TOOTH CROWNED INVOLUTE SPLINES OF 2-IN. PITCH DIAMETER

Δ, deg.	0·05	0·10	0·15	0·20	0·25	0·50	1·00	2·00
Tooth No.	Clearances, C_1, in.							
8-tooth Splines, 4/8 Pitch								
0	0	0	0	0	0	0	0	0
1	0·00000019	0·00000126	0·00000171	0·00000304	0·00000476	0·00000904	0·00007615	0·00030041
2	0·00000038	0·00000252	0·00000343	0·00000609	0·00000952	0·00001808	0·00015230	0·00060083
16-tooth Splines, 8/16 Pitch								
0	0	0	0	0	0	0	0	0
1	0·00000006	0·00000037	0·00000050	0·00000101	0·00000139	0·00000265	0·00002230	0·00008799
2	0·00000019	0·00000126	0·00000171	0·00000304	0·00000476	0·00000904	0·00007615	0·00030041
3	0·00000033	0·00000216	0·00000294	0·00000523	0·00000817	0·00001552	0·00013071	0·00051566
4	0·00000038	0·00000252	0·00000343	0·00000609	0·00000952	0·00001808	0·00015230	0·00060083
32-Tooth Splines, 16/32 Pitch								
0	0	0	0	0	0	0	0	0
1	0·00000001	0·00000010	0·00000013	0·00000023	0·00000036	0·00000069	0·00000580	0·00002287
2	0·00000006	0·00000037	0·00000050	0·00000101	0·00000139	0·00000265	0·00002230	0·00008799
3	0·00000012	0·00000078	0·00000104	0·00000188	0·00000294	0·00000558	0·00004701	0·00018545
4	0·00000019	0·00000126	0·00000171	0·00000304	0·00000476	0·00000904	0·00007615	0·00030041
5	0·00000026	0·00000176	0·00000239	0·00000424	0·00000663	0·00001260	0·00010613	0·00041868
6	0·00000033	0·00000216	0·00000294	0·00000523	0·00000817	0·00001552	0·00013071	0·00051566
7	0·00000037	0·00000242	0·00000330	0·00000586	0·00000916	0·00001739	0·00014650	0·00057796
8	0·00000038	0·00000252	0·00000343	0·00000609	0·00000952	0·00001808	0·00015230	0·00060083

TABLE 7. LIMITING LOAD VALUES FOR CROWNED 8-SPLINED MEMBERS OF 1/2 PITCH IN STEELS OF VARIOUS HARDNESSES

Brinell No.	K	Wear Load for 1-in. Contact, W_{lc}, lb.	Spline Beam Strength, lb.	Torsional Strength, 2-in. Shaft, in.-lb.
225	1,181	4,092	28,526	25,000
250	1,492	5,166	31,690	27,770
275	1,844	6,387	34,860	30,550
300	2,238	7,752	38,030	33,330
325	2,673	9,260	41,200	36,110
350	3,152	10,918	44,370	38,880
375	3,674	12,727	47,540	41,660
400	4,220	14,618	50,710	44,440
Values for induction hardened steel based on a life of 2×10^8 cycles of stress				
500	7,758	26,784	50,710	44,440

Increase of capacity with an increase from 225 to 325 Brinell:
For tooth beam strength ... ... 44 per cent
For torsion ... ... 44 per cent
For surface endurance ... ... 126 per cent

When, R_c = radius of curvature of intersection of crowned spline with concentric cylinder at the pitch radius R_1, in.;
R_1 = pitch radius of spline, in.;
ϕ = pressure angle at R_1;

then

$$R_c = R_1/\tan \phi \quad \ldots\ldots\ldots\ldots\ldots \quad (12)$$

For the 2-in. diameter spline,

$R_c = 1{\cdot}000/\tan \phi = \cos \phi = 1{\cdot}73205$ in.

LIMITING WEAR LOAD

The limiting wear load, per inch of contact depth, or per inch of depth of engagement of mating splines, is given by the following, where:

W_w = limiting load per in. of contact length, lb.;
R_c = radius of curvature of contacting surface, in.;
K = limiting load-stress value for the combination of materials (established by experiment from surface fatigue tests).

Then, $W_w = 2\ R_c\ K$ ..... (13)

For the same steel as was chosen for the previous examples, of 225 Brinell, the value of K is 1181. With steels of greater hardness up to 400 Brinell, the values of K are as follows:

Brinell No. = 250, 275, 300, 325, 350, 375, 400.
K = 1492, 1844, 2238, 2673, 3152, 3674, 4240.

Beyond spring temper hardness, steel has no endurance limit. For the hardened steels, the limiting fatigue load value for some selected number of cycles of stress must be used. In the case of crowned splines, the maximum load is applied to each pair of mating splines twice for each revolution of the splined connection. Thus, the allowable number of revolutions of the splined members will be one-half the number of cycles of stress to the probable beginning of the surface failure.

For induction-hardened steel of about 500 Brinell and for 2×10^8 cycles (two thousand million cycles of stress), the value of K is 7758.

The beam strength of the spline and the torque capacity of the shaft would also be increased with an increase in the Brinell number of the steel. These increased values are shown in Table 7 for the 8 spline, 30 deg. involute member of the 1/2 pitch, together with the corresponding values of K and the limiting wear load per in. of contact face.

LOAD AND ELASTIC DEFORMATION

The loads on crowned splines are applied substantially uniformly from crest to root, as in the case of straight splines. The elastic deformations will therefore be the same—about 0·001 in. deformation with a spline load of 4,000 lb. per in. of the face of the spline. With the 0·500-in. spline face adopted for the 2-in. diameter splined member, a spline load of 2,000 lb. will bend and compress the material to the extent of 0·001 inch. Table 8 gives the starting values needed to calculate the total load capacities given in Table 9 for misaligned crowned splines. The lower part of Table 8 gives the limiting wear loads and deformations for steels of various hardness values for splines of various pitches, all of 0·500-in. face width and 2-in. pitch diameter.

The total load calculations summarized in Table 9 are made in the same way as before. The driving splines will carry the full limiting loads given in Table 8, which will cause the tabulated amounts of deformation. Any other splines, when the tabulated amount of deformation is larger than the clearance, will carry some smaller loads. They will be deformed by an amount equal to the tabulated deformation minus the clearance. The amount of load carried will be directly proportional to the amount of deformation. When the clear-

ance is greater than the tabulated value of the deformation, those splines will carry no load.

For straight splines, the area of the section of the deformation wedge in relation to the sectional area of the deformation lamina was used as a measure of the spline load. For crowned splines, the amounts of the deformation of the several splines in relation to the maximum deformation—and load—on the driving splines will be used in the same manner.

For purposes of direct comparison, Table 9 gives calculated values for the limiting wear loads on splined members with 8, 16, and 32 splines of the same 225 Brinell steel. The loads calculated for spline No. 0 and N/4 are multiplied by 2 and those for all other spline numbers are multiplied by 4, and all these weighted values are added to obtain the total load on the splined connection. The values of the clearances are tabulated in Table 6.

TABLE 9. WEAR LOADS ON MISALIGNED CROWNED SPLINES OF 2-IN. DIAMETER IN STEEL OF 225 BRINELL HARDNESS.

Δ, deg.	0	0·05	0·10	0·15	0·20	0·25	0·50	1·00	2·00
	Maximum Loads for Wear, lb.								
8-Splined	8,184	8,181	8,164	8,156	8,135	8,108	8,039	6,975	3,735
16-Splined	8,184	8,177	8,135	8,116	8,077	8,015	7,890	5,786	2,362
32-Splined	8,184	8,171	8,111	8,082	7,994	7,887	7,612	3,573	1,673

TABLE 10. WEAR LOADS ON MISALIGNED CROWNED SPLINES OF 2-IN. DIAMETER IN STEEL OF 325 BRINELL HARDNESS

Δ, deg.	0	0·05	0·10	0·15	0·20	0·25	0·50	1·00	2·00
	Maximum Loads for Wear, lb.								
8-Splined	18,440	18,437	18,420	18,412	18,391	18,366	18,295	17,222	13,633
16-Splined	18,440	18,433	18,400	18,385	18,337	18,279	18,142	15,990	8,896
32-Splined	18,440	18,428	18,358	18,322	18,236	18,127	17,852	13,547	5,694

TABLE 8. LIMITING UNIT LOADS AND DEFORMATION FOR CROWNED SPLINES OF 225 BRINELL HARDNESS

Number of splines	8	16	32
Lewis Factor	0·713	0·817	0·892
Unit spline load for 1/2 P, lb.	28,526	32,672	35,688
For 1-in. face, 2-in. diameter, lb.	7,132	4,084	2,230
Deformation, in.	0·001784	0·001021	0·000557
Crowned splines: 2-in. diameter; 0·50-in. face; 225 Brinell steel			
Tooth strength, lb.	3,566	2,042	1,115
Pitch	4/8	8/16	16/32
Limiting wear load per spline and deformation			
Brinell No. 225 Load, lb.	1,023	511	256
Deformation, in.	0·00051150	0·00025550	0·00012800
" " 250 Load, lb.	1,292	646	323
Deformation, in.	0·00064600	0·00032300	0·00016150
" " 275 Load, lb.	1,597	798	399
Deformation, in.	0·00079850	0·00039900	0·00019950
" " 300 Load, lb.	1,938	969	484
Deformation, in.	0·00096900	0·00048450	0·00024200
" " 325 Load, lb.	2,305	1,152	576
Deformation, in.	0·00115250	0·00057600	0·00028800
" " 350 Load, lb.	2,729	1,365	682
Deformation, in.	0·00136450	0·00068250	0·00034100
" " 375 Load, lb.	3,182	1,591	795
Deformation, in.	0·00159100	0·00079550	0·00039750
" " 400 Load, lb.	3,654	1,827	914
Deformation, in.	0·00182700	0·00091350	0·00045700
Induction hardened steel for 2 × 10^8 cycles of stress			
Brinell No. 500 Load, lb.	6,696	3,348	1,674
Deformation, in.	0·00334800	0·00167400	0·00083700

COMPARING STRAIGHT AND CROWNED CONNECTIONS

A careful comparison of Tables, 4,* 5,* and 9 should be made. All these splined connections are of 225 Brinell steel. The limiting torsional load at the pitch line in all cases is about 25,000 lb. The limiting loads shown in Tables 4 and 5 for straight splined members are the beam strengths of the teeth. Those in Table 9 for crowned splines are the surface endurance limits of the materials.

For further comparisons, Table 10 gives the surface endurance capacities for crowned splines of 325 Brinell steel. Table 11 gives these values for crowned splines of 400 Brinell steel.

* MACHINERY, 99/859—11/10/61.

TABLE 11. WEAR LOADS ON MISALIGNED CROWNED SPLINES OF 2-IN. DIAMETER IN STEEL OF 400 BRINELL HARDNESS

Δ, deg.	0	0·05	0·10	0·15	0·20	0·25	0·50	1·00	2·00,
	Maximum Load, lb.								
8-Splined	29,232	29,229	29,212	29,203	29,183	29,156	29,087	28,014	24,425
16-Splined	29,232	29,226	29,188	29,177	29,132	29,079	28,942	26,790	19,576
32-Splined	29,232	29,221	29,165	29,126	29,047	28,919	28,668	24,362	11,985

Table 12 has been arranged for a ready comparison of 8- and 16-splined members of the three designs covered in this study—straight splines with 2-in. face, straight splines with 0·500-in. face, and crowned splines.

In all cases, if the 0·25 deg. angle of misalignment is assumed, the crowned spline has the greatest capacity. If the maximum misalignment is restricted to 0·20 deg., the 0·500-in. face straight splined member with 8 splines has the largest capacity; for 16 splines, the crowned splined members have the greatest capacity. If the maximum misalignment angle is restricted to 0·10 deg., the 8-spline and 16-spline members with 0·500-in. face have the greatest capacity.

All these splines are of 2-in. pitch diameter. As the diameters and pitches of the splines are changed the limiting loads also change. When the number of splines is constant, the pitch will change directly with the change in the diameter. The limiting torsional load in pounds at the pitch radius will change as the square of the radius or diameter. In terms of in.-lb. of torque, this limiting load will vary as the cube of the diameter. The limiting beam strength and the surface endurance limit load for the crowned splines will vary directly as the diameter. The elastic deformation of the spline will be the same for the same load and spline form regardless of the pitch. The clearances will vary directly with the diameters.

EFFECT OF CHANGE IN HARDNESS OF STEEL ON LOAD CAPACITIES

When harder steels are employed, the unit loads, together with the amounts of deformation under increased loads, will be increased, while the extent of the clearances will remain unchanged. Under these conditions, the limiting load capacity for any given spline and angle of misalignment will be increased somewhat more than the percentage increase in the limiting unit load. The actual amounts of these loads must be calculated. A comparison of the load values in Tables 9, 10, and 11 for the same splines made from steel of different hardnesses will confirm the above statement.

Comparison of the ratios of unit load values of steels of 225, 325 and 400 Brinell hardness for the 8-spline crowned members shows the following. The same ratios will hold good for all other numbers of splines.

For perfect alignment (Δ = 0 deg.):

225/225 8184/8184 = 1·000
325/225 18440/8184 = 2·253
400/225 29232/8184 = 3·571

For 0·25-deg. misalignment:

325/225 18366/8108 = 2·265
400/225 29156/8108 = 3·595

For 2-deg. misalignment:

325/225 13633/3735 = 3·650
400/225 24425/3735 = 6·539

It is seen that the combinations of the clearances and the increased elastic deformations give varying ratios for the several different hardness comparisons.

INFLUENCE OF DIAMETERS OF SPLINES

Finally, the limiting load conditions for 16-spline straight spline members of 4-in. pitch diameter, 4/8 pitch, and 1-in. length of engagement are compared with the 16-spline member of 2-in. pitch

TABLE 12. COMPARISON OF LIMITING LOADS ON 8- AND 16-SPLINED MEMBERS (INVOLUTE SPLINES) OF 2-IN. DIAMETER IN STEEL OF 225 BRINELL HARDNESS

Δ, deg.	0	0·05	0·10	0·15	0·20	0·25	0·50
Table No.	8-Splined Members, lb.						
4	114,112	40,440	13,820	7,304	4,480	3,100	1,456
5	28,526	28,526	27,024	15,498	10,127	7,092	2,564
9	8,184	8,181	8,164	8,156	8,135	8,108	8,039
Table No.	16-Splined Members, lb.						
4	130,688	19,250	6,700	3,560	2,360	1,720	544
5	32,672	32,670	13,574	7,306	5,048	3,424	1,184
9	8,184	8,177	8,135	8,116	8,077	8,015	7,890

TABLE 13. COMPARISON OF LOADS ON 16-SPLINED MEMBERS OF 2-IN. PITCH DIAMETER AND 4-IN. PITCH DIAMETER IN STEEL OF 225 BRINELL HARDNESS

X_1 = 4·00 in. Pitch Dia.; 4/8 Pitch; 1·00 in. Face; Straight Splines
Y_1 = 2·00 in. Pitch Dia.; 8/16 Pitch; 0·50 in. Face; Straight Splines

Limiting Beam Loads—Straight Splines.

Δ, deg.	0	0·05	0·10	0·15	0·20	0·25	0·50
X_1 lb.	130,688	130,552	57,368	30,224	19,316	13,228	4,624
Y_1 lb.	32,672	32,670	13,574	7,306	5,048	3,424	1,184
X_1/Y_1	4·000	4·000	4·226	4·136	3·826	3·863	3·905

X_2 = 4·00 in. Pitch Dia.; 4/8 Pitch; 1·00 in. Face; Crowned Splines.
Y_2 = 2·00 in. Pitch Dia.; 8/16 Pitch; 0·50 in. Face; Crowned Splines.

Limiting Wear Loads—Crowned Splines.

Δ, deg.	0	0·05	0·10	0·15	0·20	0·25	0·50
X_2 lb.	32,736	32,691	32,623	32,594	32,507	32,399	32,124
Y_2 lb.	8,184	8,177	8,135	8,116	8,077	8,015	7,890
X_2/Y_2	4·000	4·003	4·010	4·016	4·024	4·042	4·106

diameter, 8/16 pitch, and 0·500-in. length of engagement. These two splines are geometrically alike. A similar comparison is made for the limiting loads on these same splines when they are crowned. These comparisons are shown in Table 13.

By dimensional analysis, the load capacities with the same materials and geometrically similar splines should vary with the squares of the diameters. In this example, the capacities of the splines of twice the diameters should be four times those of the smaller splines. The differences in the ratios shown in Table 13 are probably the result of rounding off decimals in the calculations.

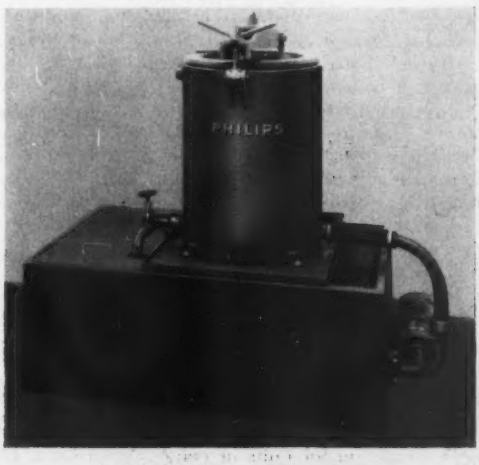
BONDERITE 250 SERIES CHROMATING TREATMENTS.—The Pyrene Co., Ltd., Great West Road, Brentford, Middlesex, have recently introduced the Bonderite 250 series of treatments for use in large-scale production. These treatments, which are carried out at room temperature, produce on hot-dipped galvanized steel, electro-zinc plated steel, or zinc-base alloys, chromate coatings that afford considerable protection against corrosion, and provide good surfaces for painting.

At present there are three treatments. Bonderite 250 produces a colourless coating with reasonable corrosion resistance, which prevents "white rusting" of parts during storage, and may be used in various circumstances where a coloured film is considered undesirable. Bonderite 251 also produces colourless coatings but with improved corrosion resistance, and Bonderite 255 gives a heavier, yellow-coloured chromate film with high corrosion resistance.

Philips Coolant Clarifier

The range of Philips machine tool coolant filtration equipment marketed by Research & Control Instruments, Ltd., Instrument House, 207 King's Cross Road, London, W.C.1, has been extended by the introduction of the pressurized clarifier here shown. This unit provides a high degree of filtration for both ferrous and non-ferrous swarf, and the filter replacement elements are inexpensive.

A ¾-h.p. pump is incorporated, which gives a flow rate of 30 gal. per min., and replaces the usual machine tool pump. The inlet system is so arranged as to ensure that the filter medium is kept clear to allow flow until the filter is full. No visual alarm system is provided, since it is claimed that the clarifier cannot overflow. The sludge capacity is 10 gal., representing approximately 2 cwt., and long machine runs are thus permitted before cleaning is necessary. With the standard 50 gal. tank, the unit occupies a floor space of 4 ft. 9 in. by 2 ft. 6 in., and the only connections required are to the mains supply and the coolant delivery outlet.



Philips pressurized coolant clarifier

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Some Advantages Gained from Flow-production of Russian IT62 Lathes

As is now well known, type 1T62 centre lathes are built at the rate of 12,000 per year at the Krasnyi Proletarii works, Moscow, and it may be of interest to consider some of the advantages gained from the adoption of mass production methods. It is claimed that when flow-line techniques were adopted, the number of man-hours required to build a lathe was reduced by 30 per cent, the number of workers required was reduced by 7·5 per cent, and the output of the factory was increased by 37 per cent, whereas the floor area was extended by only 2·5 per cent. The total cost of the introduction of mass production methods was 2·7-million new roubles.

Before the new methods were introduced, many of the lathe components were redesigned to suit the techniques envisaged. About half the total number of components were made by new methods or from new materials—32 parts from plastics, 51 by precision casting or die casting, 275 by pressing, and 100 by hot stamping or forging. As a result the weight of metal used in each lathe was reduced by nearly 3 cwt., thereby effecting a substantial saving, since material formerly accounted for 32 to 35 per cent of the total cost.

Presses with capacities up to 2,500 tons were installed in the heavy press shop, and all presses and hammers in this section were linked by conveyors to gas-fired, temperature-controlled furnaces. Forgings for type 1T62 lathes are produced with a machining allowance of only 0·060 in. per side.

In the machine shop, the greatest possible advantage was taken of carbide and multi-point tooling, when quantity production was adopted. Multi-spindle machines were provided wherever their use was justified, and planing was superseded by milling. A multi-spindle milling unit was introduced for machining lathe beds, for example, and a semi-automatic machine line with 87 tool spindles was installed for drilling these components, also high-frequency equipment for hardening the sliding surfaces.

Provision was made for pneumatic or hydraulic clamping throughout the machine shop, with extensive use of intensifiers to boost the pressure of the air from the main supply lines (60 to 75 lb. per sq. in.) to 1,800 lb. per sq. in. for clamping purposes.

Machine tools of various types were linked by mechanical transfer units or conveyors to form 41 flow lines. Two such lines are completely automatic, and were discussed in MACHINERY, 93/753—1/10/58. One of these lines provides for the manufacture of 10 different types of gears, and the other for 13 different splined shafts. Prior to the adoption of flow production, only 6·5 per cent of the machining operations were performed on special purpose machines, as compared with 31 per cent on the 150 special and transfer machines subsequently installed.

In the small components bay, a conveyor was installed alongside the machines, and above the conveyor an electrically-driven trolley was provided. Standardized containers were designed to hold the components, and the arrangements are such that they can be moved along the conveyor by the trolley, to which they are attached by special gripping units. Where required, hydraulically-powered lifting units are installed to raise the containers to the level of the conveyor. The number of items of inspection equipment for checking the components was increased to 400, and includes multi-position units for spindles and shafts.

Transport of finished components from the machine shop to an intermediate store and thence to the assembly lines was mechanized. Standard trays or boxes were designed for all small components, and a 2-stage conveyor was installed as an extension to the automatic lines to connect the machine shop to the store. In addition, an overhead chain conveyor was provided to transport the components, still in trays or boxes, to the assembly lines. The conveyor was arranged so that the containers were suspended by attachments of three different lengths, according to their destination, and unloading units were provided to disconnect the appropriate attachments automatically at each assembly line. Underground conveyors were installed for the transport of large components, such as beds, directly from the machine shop to the assembly lines. It is estimated that the installation of automatic conveyor systems reduced the total number of employees engaged in work-handling by 50 per cent.

An intermittently moving conveyor was provided for final assembly, and three continuously moving conveyors for building sub-assemblies. Also, provision was made for automatically washing headstocks prior to inspection. It is considered that the mechanical aids installed reduced the time required for assembly operations by 31 per cent.

Roller conveyors and pneumatically-powered handling units were installed in a special room for filling and priming castings before machining, and air-operated rubbing-down equipment was provided for smoothing the filled surfaces. A trolley conveyor was laid down for final painting, and a belt conveyor for preparatory filling. It is stated that the conveyors and other equipment increased the productivity of the painting department by 20 to 25 per cent.

Ferranti Automatic Drilling Machine for Printed Circuit Boards

In Fig. 1 is shown an automatic machine which has recently been developed by Ferranti, Ltd., Ferry Road, Edinburgh, for drilling large numbers of holes in printed circuit boards.

During the operating cycle, the 20- by 14-in. co-ordinate setting work-table is moved in one direction, in steps, for drilling holes in one row in the workpiece. It is then moved in a direction at right-angles and set for drilling the holes in the next row. An extension at the right-hand end of the table carries a template as shown in the close-up view Fig. 2, in which there is a number of holes at positions corresponding to those required in the printed circuit board. For coarse positioning, for drilling holes in one row, the table is traversed by a hydraulic cylinder until a beam of light from a lamp unit passes through one of the holes in the template. As a result, a photo-electric cell is energized, and the supply of pressure fluid to the hydraulic cylinder is interrupted to stop the table. At the same time, a half-nut is brought into engagement hydraulically with a precision rack for accurately positioning the table, and the drilling cycle is then started.

When the drilling cycle has been completed. a signal from the spindle head is transmitted to the control system, with the result that the half-nut is brought out of engagement with the rack, and pressure fluid is again delivered to the hydraulic cylinder, to move the table to the next position. After all the holes in one row have been drilled, movement is imparted to the table in the direction at right-angles by another hydraulic cylinder, and there is a second half-nut and rack which provide for accurate positioning in readiness for drilling holes in the next row. Two sets of holes are provided in the template for controlling the centre distance between adjacent rows of holes.

Half-nuts and racks provided with different pitches can be employed for positioning the table in either direction, if required. When a half-nut and rack with a pitch of 20 t.p.i. is employed, for example, holes can be drilled in the work at various centre distances in multiples of 0·050 in. It is stated that the system enables the table to be positioned to an accuracy of ±0·001 in., and that settings can be repeated within 0·001 in.

There are two Dumore Series 20 drilling heads (Automation, Ltd., Devonshire House, Vicarage Crescent, London, S.W.11), which have a chuck capacity of $\frac{5}{16}$ in. A direct drive to the spindle on each head is taken from a series-wound electric motor, the operating speed of which is automatically governed in the range from 2,500 to 7,000 r.p.m. in accordance with the diameter of the drill and the work material. Feed is applied

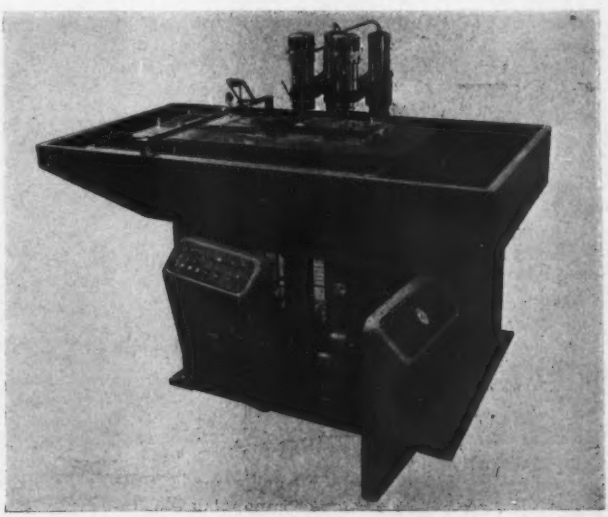


Fig. 1. Ferranti automatic drilling machine for printed circuit boards

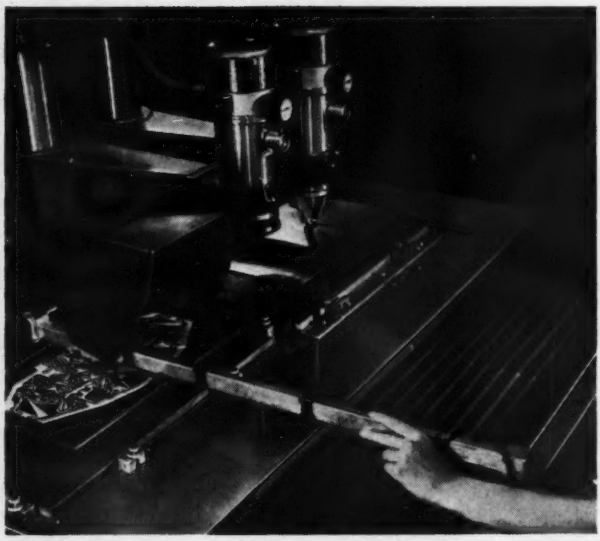


Fig. 2. Close-up view of the template carrier and drilling heads on the Ferranti machine

to the spindle by compressed air supplied by a 3-vane compressor which is driven from the upper end of the motor shaft. A pressure regulator is incorporated in the compressed air system for adjusting the drilling feed.

If only one spindle head is employed, holes can be drilled within a space measuring 11½ by 17½ in. in a single printed circuit board up to 12½ by 18 in.—or a stack of boards with a maximum thickness of ⅜ in. When both heads are used, two printed circuit boards, or stacks of boards, up to 12 by 8½ in. can be handled simultaneously, and holes can be drilled in each board within an area of 11½ by 7¼ in.

A machine of this type is employed at the company's works for drilling printed circuit boards for Ferranti Argus computers, each of which measures 5½ by 7½ by $\frac{1}{16}$ in. thick, and has 288 holes. Eight boards in two stacks are handled at each setting, and loading, drilling and unloading are completed in 14½ min.

The machine weighs about 18 cwt., and occupies a floor space of 49 by 42 in.

Sintercast Ferro-Tic J Machinable Cutting Grade Carbide

The Sintercast Division of Chromalloy Corporation, 171 Western Highway, West Nyach, New York, U.S.A., have introduced Ferro-Tic J cutting grade carbide which is stated to combine the hot hardness required in high-speed metal cutting with the easy fabrication characteristics of earlier grades of Ferro-Tic carbide. As supplied in the annealed state, this fully-sintered composition of hard carbide particles dispersed in a high-speed steel matrix can be turned, drilled, milled, tapped, and filed. After being heat-treated to hardnesses up to 70 Rockwell C, by conventional methods, however, the material behaves like solid carbide.

Service life when machining heat-treated steels, it is claimed, is comparable with that of ordinary carbides. Metal removal rates and tool life are much higher than for high-speed steel and the cost of the material is stated to be intermediate between those of conventional solid carbide and high-speed steel.

Examples of drills and end mills made from Ferro-Tic J are shown in the accompanying illustration, and the material is also suitable for producing milling cutters, broaches and form tools.

Examples of drills and end milling cutters made from machinable Ferro-Tic J carbide

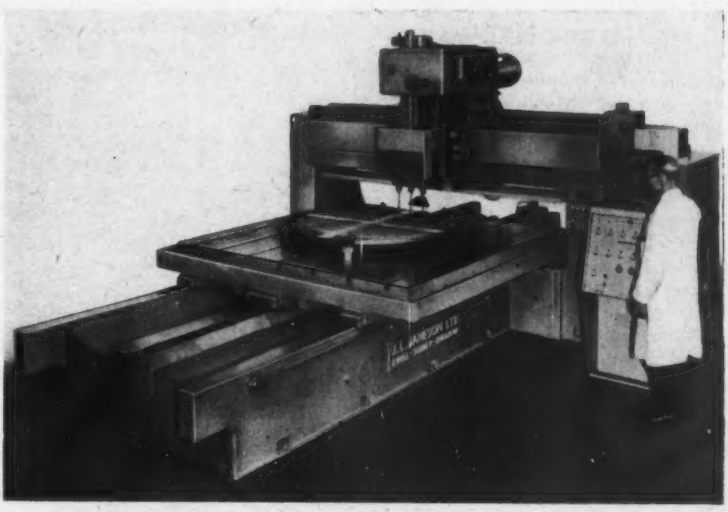
Jameson Punched-tape Controlled Co-ordinate Drilling Machine

DESIGNED AND BUILT by J. L. Jameson, Ltd., West Street, Ewell, Surrey, the punched-tape controlled co-ordinate drilling machine shown in the figure has been supplied recently to a well-known company in the South of England for operations on condenser tube plates. These plates incorporate large numbers of holes, which require to be drilled, reamed, and in some instances internally-grooved, and the machine is designed to operate on a fully-automatic cycle for each of these stages. Of the double-column, fixed-rail type, it has a T-slotted table with a working surface of 84 by 84 in. which is arranged to move longitudinally beneath the rail. Sliding transversely on the rail there is a 3-spindle drilling head and saddle, and the maximum area which can be covered by the centre spindle is 72 by 72 in.

The various hole positions required are obtained by combined, and simultaneous, movements of the table and saddle, under the control of Airmec punched-tape equipment, and the machine can be supplied arranged for control by other systems if desired. When the table and saddle have taken up the required positions, they are automatically clamped, and down feed to the spindle head is engaged. At the end of a drilling operation, the spindle head is automatically raised rapidly, and the table and saddle are moved to fresh positions. The drilling cycle is then repeated.

The work-table is of cast iron, and on the underside there is a centrally-located portion which extends for the full length and engages a narrow guide projecting upwards from the throat of the fabricated steel bed. The guide in the bed is of channel-section, and serves to house the recirculating-type ball screw whereby the table is traversed. Extending along each edge of the upper surface of the bed there are channel-section ways which house Renold roller-chain-type anti-friction sliding elements, whereon the table is supported. Each unit is an endless loop, and the slack side, which passes through apertures in the bed, is supported at three positions by free-running rollers. Flexible steel strips are provided to cover the tops of the channels, wherein the rollers run, and these strips are secured at each end to the bed and pass through slots in the work-table. A similar arrangement is provided to seal-off the central channel, to protect the traverse screw.

Also projecting from the under-side of the table, and to one side of the guiding portion, there is a rectangular-section steel plate, mounted on edge, and this plate passes between the jaws of a pincer-type hydraulically-operated clamp secured to the bed. When this clamp is applied, it grips the steel plate and clamps the table, and with this arrangement the latter is securely locked during drilling without the risk of disturbing its position



Jameson punched-tape controlled co-ordinate machine for drilling, reaming and internal grooving operations on condenser tube plates

longitudinally. Drive to the table screw is from a 2-speed f.h.p., or d.c., motor and gearbox, flange-mounted at one end of the bed, and provision is made for turning the screw by hand, for setting purposes. A maximum longitudinal traverse of 90 in. is provided for the table, so that it can be brought well clear of the rail, to facilitate loading workpieces.

The cross-rail is a ribbed cast-iron structure which is secured to large flat surfaces provided at the tops of the columns, and the latter, in turn, are tenoned and bolted to the sides of the bed. There are flat guideway surfaces on the front face of the rail for the saddle, and the lower guideway is extended downwards and is of dovetail section. Flat ways are also provided along the top of the rail, for free-running rollers which are mounted in the saddle casting. The saddle is supported by these rollers, and other rollers are provided which engage with a flat surface extending across the back of the rail. The recirculating ball screw, whereby the saddle is traversed along the rail, is housed in a channel in the top face of the latter, and drive is taken from a 2-speed f.h.p., or d.c., motor and reduction box at the right-hand end. Provision is also made for turning this screw by hand. Rapid traverse at rates between 60 and 300 in. per min. is provided for the saddle on the rail, also for the table on the bed.

The saddle carries the 15-h.p. spindle driving motor, and incorporates the gearboxes for spindle speeds and vertical feed rates to the spindle head. Six spindle speeds are provided, within the range 77 to 318 r.p.m., but other ranges can be provided up to a maximum of 145 to 600 r.p.m. Output from the spindle driving gearbox is by way of a splined shaft which projects vertically downwards and enters the spindle head. Feed rates to the latter range from 0·005 to 0·060 in. per spindle rev., in ten steps The feed motion is engaged by means of a magnetic clutch, which is controlled through limit switches actuated by adjustable dogs on the drilling head.

The spindle head is raised and lowered by a screw and nut, and a separate motor and belt drive are provided for rapid approach and withdrawal from the work. A stroke of 15 in. is provided for the spindle head, and the maximum distance obtainable between the noses of the spindles and the working surface of the table is 22 in.

The multi-spindle head is of the interchangeable type, so that other designs with different numbers of spindles, at various centre-distances, can be fitted if required, and a feature of the machine is that the head only is raised and lowered for drilling purposes. Since it is relatively light in weight, the need for counterbalancing has been eliminated. Provision is made for raising and lowering the spindle head by hand, for setting purposes.

The punched-tape control equipment, and tape reader, are housed in a separate, free-standing cabinet at the right-hand side of the machine, as is the electrical control cubicle. Provision is made for applying coolant to the drills, and the table incorporates an integrally-cast collector channel which discharges by way of a chute at one corner into a sheet steel trough that extends for the full length of the bed at the left-hand side. A separate pump raises coolant from this trough and returns it to the working zone.

IMPROVED METHOD FOR WELDING THICK ALUMINIUM PLATE.—The Kaiser Aluminum & Chemical Corporation, U.S.A., have developed a method of welding thick aluminium plate by the use of large-diameter filler wire, for which advantages are claimed. Welding costs are reduced with the new method, it is stated, because a filler deposit rate of 15 lb. per hour is readily obtainable, and rates in excess of 20 lb. per hour are possible for special applications.

Butt welds have been made in 3-in. plate in 5083 and 5456 aluminium alloy which meet the requirements for pressure vessels, and have good ductility. To enable filler wire of diameters up to $\frac{7}{32}$ in. to be employed, heavier wire feeders and adequate power supplies are necessary. Most submerged arc equipment used for steel can be converted for welding with the large aluminium wires by replacing the flux and contact tube systems with water-cooled inert-gas welding barrels of sufficient capacity.

For the new process with the larger wire, current density in the range from 15,000 to 30,000 amp. per sq. in. is suitable. Various mixtures of argon and helium may be used for shielding, and only two welding passes are normally required for plate up to 1½ in. thick.

It is reported that 3-in. thick plates of 5083 aluminium alloy have been successfully butt welded using 5183 filler wire of $\frac{7}{32}$ in. diameter. The butting plate edges were prepared with a V-groove on each side and the operation was completed in three passes on each side.

EXPORTS OF DRILLING MACHINES. In the nine months ending September 30, 1961, drilling machines to the value of £1,088,573 were exported, as compared with a value of £942,257 for the corresponding period of the previous year.

Transplant-coated Aluminium Cylinder Bores*

By A. F. BAUER†

THE INTRODUCTION OF aluminium die castings for the combined crankcase and cylinder block components of internal combustion engines in the U.S.A. at first necessitated the use of cast- or pressed-in grey iron liners or sleeves. Effective anchorage of many cast-in liners is ensured by providing external grooves into which the aluminium is forced during casting, the subsequent shrinkage providing a secure grip. Millions of such cylinder castings have been made, and only in a few cases have difficulties been experienced as a result of separation of the aluminium from the liner wall.

In modern, high-efficiency, multi-cylinder engines, the risk of separation is greater on account of the large quantities of heat which have to be dissipated. A very effective method of joining the liner to the aluminium is by the A1-Fin process, but it is not well-suited to high-speed pressure die casting operations, and extensive research work was therefore carried out by Doehler-Jarvis to develop a method of bonding suitable for die casting. One of the first results of this research was the production of liners having rough external surfaces, with undercuts which are filled by the aluminium during the die casting operation.

As described in MACHINERY, 99/516—30/8/61, this process, which provides for what is known as bi-metallic interlock, or BMI for short, gives extremely high-strength bonds in pressure die castings, which have good heat conductivity and freedom from separation. Other methods which were investigated included the use of protective coatings of the cylinder walls by electro-deposition of chromium and by metal spraying. These methods are considered to be more expensive than the use of cast-in sleeves, however, although they have applications in small engines for power tool and other applications in which lightness is particularly important.

* Abstracted from a paper given to the 1961 Summer Meeting, Society of Automotive Engineers, Inc., 485 Lexington Avenue, New York 17, N.Y.

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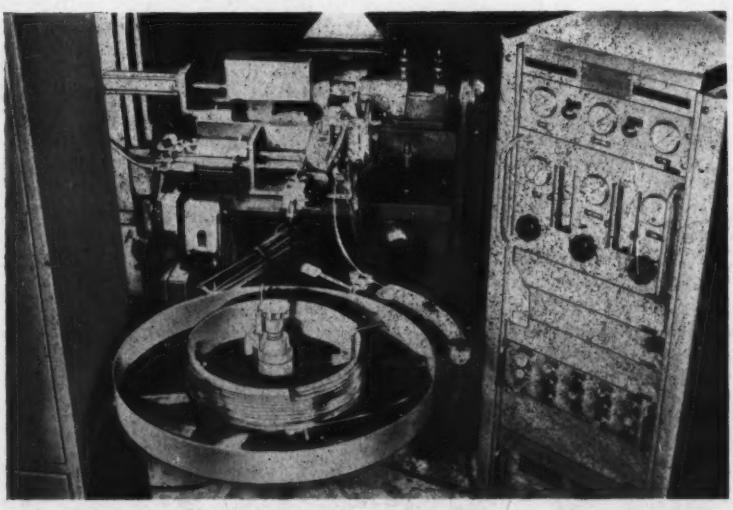


Fig. 1. Part of a pilot plant set up to permit evaluation of the " transplant " process of providing a hard coating in the bores of pressure die cast aluminium engine cylinders, this lathe will coat cores at rates up to 80 per hour

TRANSPLANT COAT PROCESS

With a new process which has been recently developed, a coating of metal is first built up on the core employed to form the cylinder bore in the die casting die. The coat is produced by the metal-spraying process, and the procedure could readily be automated by providing special equipment. A lathe which forms part of a pilot plant installed to try out the method is shown in Fig. 1, and has a capacity for 80 cores per hour, sufficient for twenty 4-cylinder blocks. The core is sprayed with

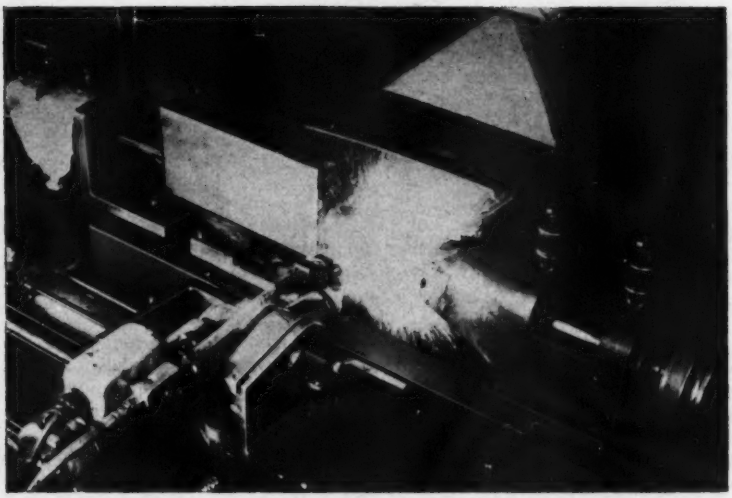


Fig. 2. Close-up of the lathe in Fig. 1, in operation on a core for an engine cylinder casting die. The core is draftless, and metal can be built up to any required thickness, about 0·02 in. being usually applied

material of any desired composition and is rotated as the gun is traversed to build up a coating of the required thickness.

Normally a thickness of 0·020 in. is sufficient, and can be obtained with about 20 passes of the gun. A close-up view showing the machine in operation is given in Fig. 2, and it can be arranged for electronic control to produce a deposit of varying thickness if necessary. When a core which has been sprayed in this manner is inserted in a die, the aluminium, injected under the usual high pressure, penetrates the rough surface and enters the pores of the sprayed coating. This penetration produces a very strong bond between the coating and the casting, and when the draftless core is withdrawn the coating is left in position in the cylinder bore. For this reason, the name transplant has been adopted for the process.

A section, at 80× magnification, showing the junction between the injected aluminium coating and the sprayed metal coating is shown in Fig. 3, and clearly indicates the nature of the bond obtained. Because the sprayed metal is originally deposited on a smooth surface, the interior walls of the cylinder are smooth and parallel, and a minimum of machining is therefore required to finish the bore to size.

During experiments to determine the strength of the bond between the sprayed coating and the cylinder walls, sections cut from a cylinder provided with a heavy coating were subjected to shear tests. For these tests, in all of which failure occurred through the aluminium, an average shear strength of 14,000 to 15,000 lb. per sq. in. was recorded. Other tests which were carried out under such conditions that deformation of the test ring was avoided, and the shear line passed through the bond between the aluminium and the transplant coating, gave shear strength figures in excess of 21,000 lb. per sq. in.

Tests in which the cast metal was pulled away from the coating in a radial direction produced failures at average values of 4,000 to 4,200 lb. per sq. in., for different coating thicknesses, and all failures occurring in the sprayed metals and not in the bond. Castings incorporating transplant coatings were melted away with a blow torch in efforts to separate the aluminium from the coating, but the aluminium which had penetrated the pores could not be removed in this manner. When the coating was honed away until the aluminium showed through there was still no tendency for the sprayed metal to separate from the casting.

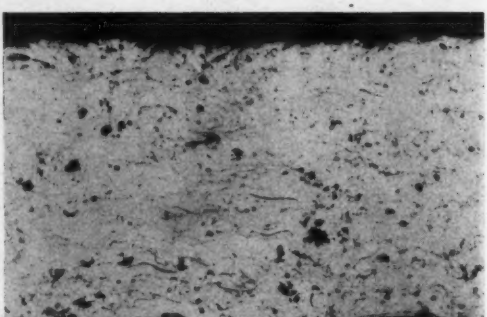


Fig. 3. Section, at 80× magnification, through the bond area

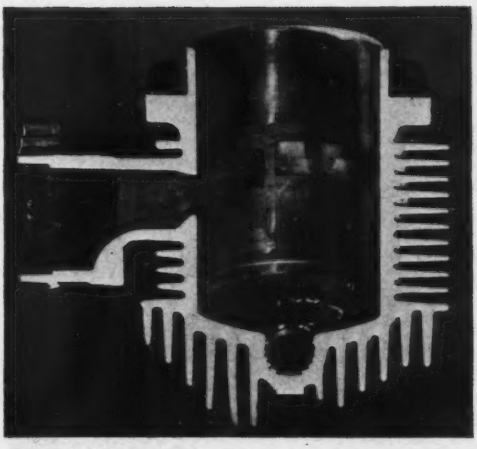


Fig. 4. A section cylinder after a dynamometer test of 975 hours' duration at 7,000 r.p.m.

Dynamometer and road tests have also been carried out on various engines with transplant-coated cylinder bores. Satisfactory results were obtained from all these tests, the coatings employed having been selected to provide the required degree of hardness and a pore size comparable with that of cast iron, to retain lubricant.

In one instance, a portable air-cooled engine, with a cylinder bore of 2 in. diameter, was subjected to dynamometer testing for 975 hours at 7,000 r.p.m., after which it was sectioned as shown in Fig. 4. It was found that the bore surface was still smooth with no signs of scuffing, and wear did not exceed 0·002 in.

Preparations for the application of the transplant process to cylinders for small air-cooled portable engines made by pressure die casting are now in progress. Automated equipment will be employed, and it will be possible to determine the economics of the process and the quality obtained under production conditions.

Electro-mechanical Measuring Equipment for Coil Cut-up Lines

An electro-mechanical measuring device for coil cut-up lines, which replaces an end stop and retracting run-out track, has been introduced by Press Equipment, Ltd., Hunters Vale, Birmingham, 19, and a typical installation is shown in the figure. This device, which operates in conjunction with the straightening unit, detects the amount of material passing through the outgoing pinch rolls, and automatically stops the straightener and operates the shear when the required length has been metered. It is automatically reset, with the result that straightening and measuring start again immediately the shear blades open.

Lengths are set on two dials, one of which provides for feet and the other for inches, and it is stated that sheets can be cut to $\pm 0{\cdot}015$ in. irrespective of the dimension. With this arrangement, the output side of the shear is left clear for a conveyor, or other take-off or stacking system.

The installation illustrated handles 36-in. wide by 0·048-in. thick strip, and incorporates a decoiling unit with power-driven pinch rolls whereby the material is drawn off a roller-bearing-mounted mandrel. A Hunatron unit, controlled from a catenary detector between the decoiler and straightener, automatically regulates the speed of the pinch rolls. This equipment can be adapted for aluminium strip down to 0·007 in. thick.

Coil cut-up line with electro-mechanical measuring device developed by Press Equipment, Ltd.

Redman 35-ton Universal Hydraulic Press

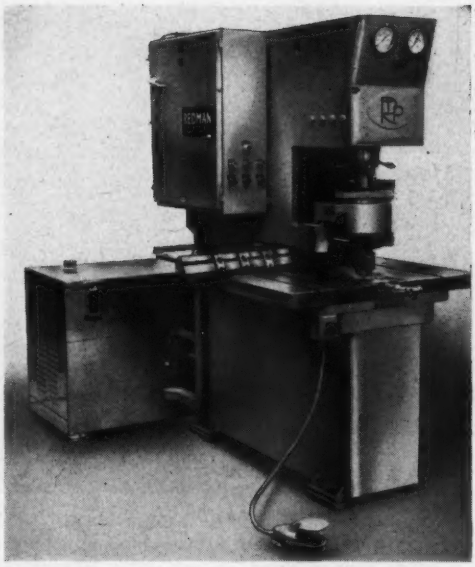


Fig. 1. The Redman 35-ton universal hydraulic press, here shown, is designed for use with a variety of standardized tool assemblies and units

RECENTLY INTRODUCED BY Redman Tools & Products, Ltd., Gregorys Bank, Worcester, the 35-ton universal hydraulic press shown in Fig. 1 is designed to enable setting up to be accomplished rapidly, to facilitate the production of small-quantity batches, and it has capacity for piercing holes up to 1½ in. diameter in ¾-in. thick mild steel. Provision is made, moreover, for the use of items from the company's Unipierce and Unicrop ranges of unit tools, to permit such operations as nibbling, notching, and embossing to be performed, and it is stated that areas measuring 4 by 4 in. and 2⅛ by 2½ in. can be notched from mild steel plates with thicknesses of $\frac{5}{32}$ and ¾ in., respectively.

Individual, interchangeable piercing punch and die units are employed, which are carried at the outer ends of the upper and lower arms, of a C-frame unit of similar design to the Unipierce unit. This C-frame has a throat depth of 18 in., and it is mounted in a lateral slot in the work-table, so that the working surface is unobstructed. Two typical sets of tools are seen on the table at the right in Fig. 2, which is a close-up view of the working area, and it should be noted that the punch assemblies, which incorporate cylindrical holders for the short punch members, are shown inverted.

During the pressing cycle downward movement of the ram of a hydraulic cylinder, housed vertically in the crown of the machine, is transmitted to the punch assembly by way

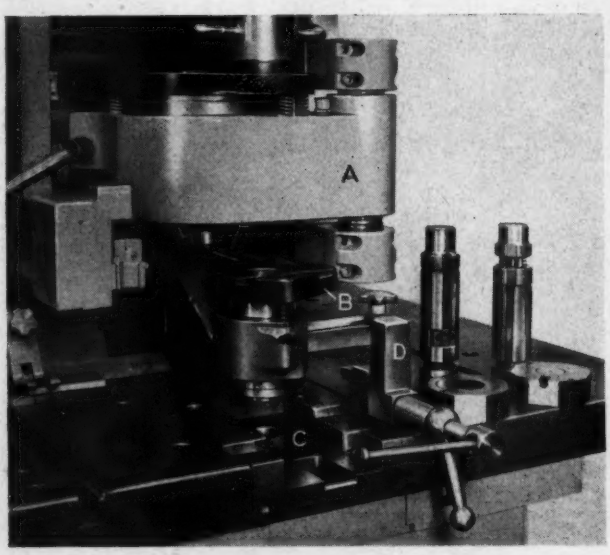


Fig. 2. Interchangeable piercing punch and die assemblies are housed at the ends of the arms of a C-frame unit, which is mounted in a lateral slot in the work-table, as shown in this close-up view. Typical assemblies can be seen at the right-hand side of the table

of the stripping head *A*. This head is not coupled to the ram, and for tool changing, it is swung to the rear, about a pivot at the right-hand side, to the position shown in the figure. In this way, access is afforded for removing the punch assembly, which is merely withdrawn from the bore of the flanged sleeve *B*, housed in the C-frame, a fresh assembly being then inserted. A key is provided in the housing, to locate the assembly angularly, and there are two ways in the punch holder, to permit the punch for a non-circular shape to be set at positions which are 90 deg. apart. Finally, the stripping head is returned to the original position and locked, in readiness for operation.

The die is mounted in a ring-shaped holder, and when in use, this assembly is housed in a recess in the outer end of the associated arm of the C-frame unit, as indicated at *C* in Fig. 2. Four flats on the periphery of the holder, in conjunction with the side and end faces of the recess, serve to locate the assembly angularly, and enable it to be located to correspond with the punch setting when a non-circular shape is to be pierced. Seen in the open position, the arrangement whereby the die assembly is clamped in place incorporates a screw, threaded through the arm *D*, which is pivotally mounted on the C-frame unit. For clamping, the arrangement is swung anti-clockwise through about 90 deg., and the screw is then turned by means of the lever at the outer end, to engage the thrust block at the opposite end with the die assembly, which is thus held against the rear face of the recess. Finally, a long lock-nut, carried on the outer portion of the screw, is tightened against the face of the arm *D*. With this arrangement, the die assembly is quickly clamped and released.

To avoid the possibility of damage being caused due to the die being incorrectly positioned, there is a microswitch at the rear of the recess, whereby operation of the press is prevented unless the assembly is fully home. Another microswitch prevents operation unless the stripping head is locked in the forward position.

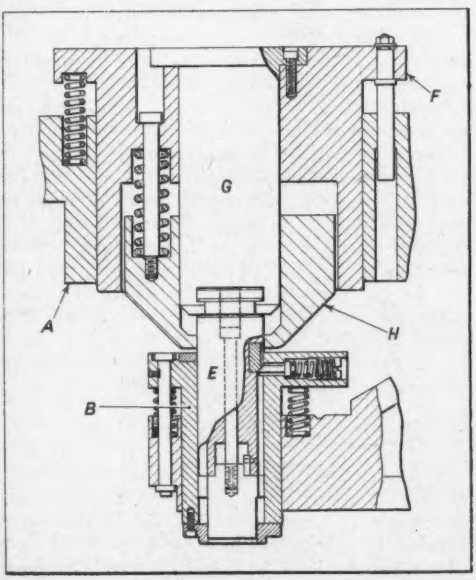


Fig. 3. Sectioned side elevation of the stripping head, whereby motion is transmitted from the press ram to the punch assembly, and the end of the upper arm of the C-frame

PUNCH HOUSING AND STRIPPING HEAD

Various methods are used for securing the punch member to the holder, depending on the size, and for piercing very small holes, the assembly incorporates a spring-loaded stripper bush. Such an assembly is seen at the right of the pair shown in Fig. 2. A separate system is normally employed for stripping, however, and in Fig. 3, which is a sectioned side elevation of the stripping head and the end of the upper arm of the C-frame, an assembly of the usual type is indicated at *E*.

The flanged sleeve *B*, in which the punch assembly is housed, can slide in a vertical bore in the arm of the C-frame unit and is spring-loaded upwards. Two spring-loaded detent pins, housed in the flange, engage inclined stop faces on the periphery of the holder, to ensure that it projects above the upper face of the flange by a known amount, and attached to the lower end of the sleeve there is a stripper bush. Mounted in a large-diameter vertical bore in the stripper head *A*, the flanged sleeve *F* is urged upwards by compression springs, and the plug *G* is secured in the bore of this sleeve. The conical-ended sleeve *H*, which is attached to the sleeve *F* by long shouldered bolts, is spring-loaded downwards and is guided by the lower portion of the plug. Corresponding openings cut in the wall of the sleeve *F* and the plug, as may be seen in Fig. 2, permit the lower ends of these members to pass across the projecting upper portion of the punch holder when the head is swung to the forward position. In this way, an annular rib at the lower end of the plug is engaged with a groove close to the upper end of the holder, as shown in Fig. 3, to couple together the sleeve *F* and the punch assembly.

In operation, the adjustable nose-piece on the press ram is brought into contact with the upper

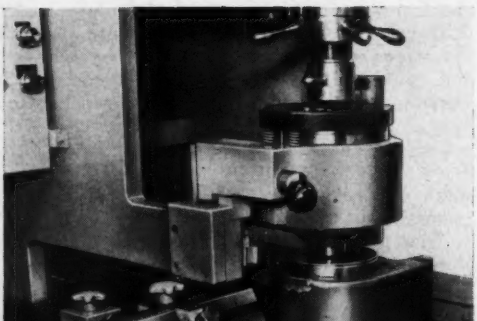


Fig. 4. One of the company's Unicrop tools is here shown in the working position. When one of these units, or a Unipierce tool, is to be employed, the C-frame is pushed to the rear along roller ways

face of the plug and sleeve assembly at an early stage during the downward movement, and further motion thus causes the assembly—and consequently the punch—to be thrust downwards. Subsequently, the conical-ended sleeve *H* contacts the upper face of the sleeve *B*, which is then moved downwards to bring the stripper bush into contact with the surface of the work. Further movement of the ram causes the punch assembly to slide through the associated sleeve, to penetrate the work, and serves to compress the springs acting on the sleeve *H*, to provide force for stripping during the return stroke. The scrap passes downwards through the die and openings in the seating for the C-frame, and is collected in a wheeled container in the base of the machine.

USING UNIPIERCE AND UNICROP TOOLS

When a Unipierce or a Unicrop tool is to be employed, the fitted bolts whereby the C-frame unit is located and secured in the working position are removed, and the entire unit is then pushed clear of the working area, along roller ways on an extension structure at the rear of the table. To facilitate initiation of the movement, a roller is raised by means of a lever, to lift the unit slightly.

Bushed holes in the plate which forms the seating for the C-frame provide for the use of location dowels in patterns corresponding to the location holes which are drilled in the bases of the Unicrop range, and with this arrangement, each unit is quickly set to the same working position as the C-frame. One of these units may be seen in use in the close-up view in Fig. 4.

Unipierce units are mounted in a similar manner, and a bolster is provided which is located and secured to the seating by fitted bolts. Bushed holes in this bolster provide for the use of dowels in patterns corresponding to the holes in the bases of Unipierce units, for setting to the common working position. When using UP and UC units, a plug is inserted in the member *G*.

An adjustable stop system is provided for locating the work, and the number of stops, and their design, can be varied to suit requirements. On the machine illustrated, the single back stop consists of a bar, which is carried in a recess in the underside of the housing *J*, Fig. 4. This bar can be adjusted laterally, and can be extended through the throat of the C-frame, and after it has been set, it is clamped to the housing by means of bolts which engage a T-slot in the upper surface. The entire assembly can be adjusted towards and away from the operator, with reference to a graduated scale in the surface of the table, and a block, which is connected to the rear of the housing by an adjusting screw, may be clamped to the table, to facilitate accurate setting. When it has been positioned, the assembly is clamped to the table by T-bolts.

Three or more side stops are used, to enable holes to be pierced successively at different positions in the work without the need for re-setting, and they can be adjusted along a T-slot in the inclined front face of the housing and set with reference to a graduated scale on the upper surface. It may be noted that the zero points of both the scales are coincident with the vertical axis of the punch and die. On each unit, the stop is formed by an arm, which is pivoted to the mounting bracket and may be swung upwards, clear of the work.

BAR EJECTOR DOOR FOR SWARF PULVERIZER Christy & Norris, Ltd., Chelmsford, have introduced ejector doors of new design which can be applied to all swarf pulverizers in their range. This attachment, it is stated, is simple and inexpensive to install, and ensures that any bar ends, either steel or non-ferrous, are ejected before they can cause damage to the screen bars. A bar end is thrown upwards beneath the feed chute plate, strikes the hinged door, and is then discharged.

New Range of Dixi Jig-boring Machines with Numerical Control

ON SHOW FOR THE FIRST TIME at the 7th European Machine Tool Exhibition, held recently in Brussels, was an example from the latest range of jig-boring machines built by Dixi S.A., Usine 2, Le Locle, Switzerland, for whom the agents in this country are Dowding & Doll, Ltd., 346 Kensington High Street, London, W.14. Known as the type 3S range, it comprises four machines, which are all basically similar in capacity but differ as regards the method of control, and various auxiliary equipment. The machine exhibited was the type 3 SAE, which is the most advanced of the range and has provision for positioning the table longitudinally and transversely, and the spindle head vertically, by manual adjustment, in conjunction with optical equipment; by means of a bank of push-buttons, whereby the required positions are set numerically; or by punched-tape. The second and third methods mentioned above can also be combined, in that the push-buttons can be used for setting the machine for the first workpiece in a batch, and can be arranged to produce, simultaneously, punched-paper strips, or a punched-paper tape, for controlling the machine for subsequent identical workpieces.

Basically, the new machine follows the well-known Dixi design, as can be seen in Fig. 1. Certain modifications have been made, however, notably in connection with the spindle head and drive, to provide increased rigidity and to ensure improved performance and accuracy. A diagrammatic sectional view, in a horizontal plane, of the twin columns and the spindle head, is shown in Fig. 2, and it will be noted that the head is provided with a large prismatic guide at one side, which engages with a V-way in the larger of the two columns. At the other side, the spindle head has a large flat guide surface and a mating face is provided on the smaller column. The spindle head casting extends through the gap between the columns, and there is a pair of flat guide surfaces at the rear of the gap, with adjustable gib strips, as at *A*. Attention is drawn to the fact that the inside faces of the columns are extended inwards, towards each other, in order to reduce the distance from the centre of the V-guide to the axis of the spindle, and thus increase the effectiveness of the guiding action. The T-slots seen in the guiding surfaces on the front of the column provide for clamping the spindle head in the required position vertically.

Another feature of the design is that the spindle is driven directly, through a special coupling *B* at the rear end, and with this arrangement it is relieved of all transverse driving load, such as may be imparted by the separating forces between gears, for example. Drive is transmitted either directly to the spindle, by way of the shaft *D* within the casing *C*, or through a 2-stage reduction gear, also housed within the casing and arranged to drive the shaft *D*. The reduction stage comprises two pairs of hardened and ground helical gears, which are arranged to mesh with the minimum practical backlash. Drive to the shaft *D* is transmitted by a flat pulley at one end, which is

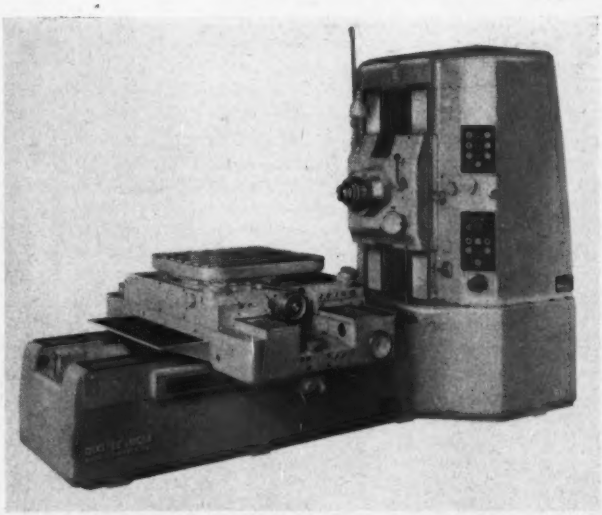


Fig. 1. The Dixi type 3 SAE jig-boring machine with numerical control is one of a new range recently introduced by the company

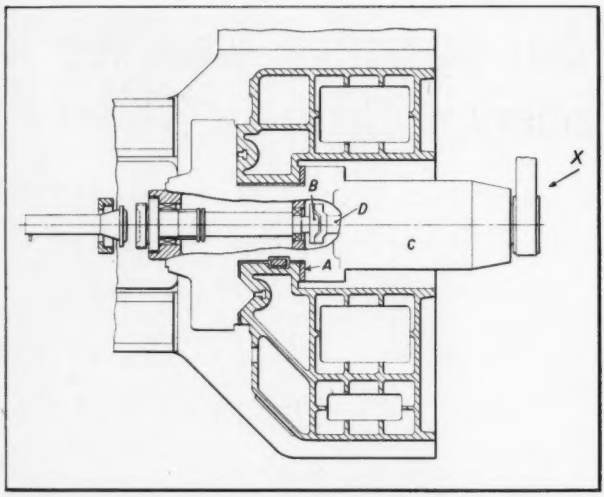


Fig. 2. Diagrammatic sectional view, in a horizontal plane, of the spindle head and twin columns employed on the new range of Dixi jig-boring machines

seen clearly in the close-up view Fig. 3, where it is indicated at *E*. This view shows the rear of the machine, and is taken approximately in the direction of the arrow *X*, Fig. 2.

Mounted coaxially with the pulley *E*, and arranged to pivot on a bearing on the casing *C*, there is a heavy arm *F*, and the lower end of this arm carries a bearing wherein a short shaft is free to rotate. At one end of the shaft there is a pulley *G*, which drives the pulley *E* by way of a flat belt, and at the other end of the shaft there is another pulley which is driven directly from the steplessly-variable d.c. motor at the right. An arm *H*, similar to that at *F*, connects the lower end of the latter to a pivot point on the motor, coaxial with the output pulley. Each of the arms *F* and *H* is provided with turn-buckle-type adjustment for length, to enable the required tensions on the associated flat belts to be maintained.

It will be appreciated that as the spindle head, and therefore the pulley *E*, is raised and lowered, the arms *F* and *H* will pivot about their anchorages, and will "jack-knife," but the centre distance of each pair of pulleys will remain constant, as will the tensions of the belts. For the high range of spindle speeds, up to 2,500 r.p.m., drive is by means of the belts only, and exceptionally quiet transmission is obtained. For the low-speed range, up to 1,600 r.p.m., the 2-stage reduction gearing in the casing *C* is introduced, and as already mentioned, the gears are specially made and mounted to ensure a smooth and quiet drive.

The new transmission system has enabled the main motor, which is of 8 h.p. and is Ward-Leonard controlled, to be mounted separately from the machine, to isolate the latter from a possible source of vibration and heat, and has eliminated the more complex arrangement of splined shafts and gearboxes whereby drive is transmitted on earlier machines.

Another design change in connection with the head is that on the new machine no axial movement is provided for the spindle. Instead, feed for boring is provided by longitudinal movement of the table, and with this arrangement the workpiece is fed over the tool. As a result the overhang of the tool from the point of support in the head is always maintained at the minimum, which is only slightly in excess of the depth of the hole to be bored. With an axially-feeding

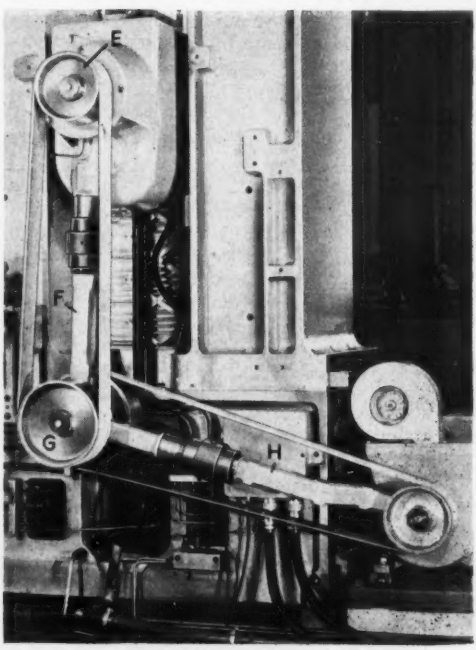


Fig. 3. This close-up view shows the new belt drive arrangements to the spindle head

Fig. 4. A close-up view of the spindle head on the Dixi type 3 SAE jig borer

23⅝ in. Counterweights housed in the columns compensate for the weight of the head, and the slideways on the columns are fully-protected. A close-up view of the spindle head is shown in Fig. 4, and the lever at *J* serves to engage the 2-stage reduction for the spindle drive. Another lever, at *K*, is used to lock the spindle head to the columns when the required vertical position has been reached. The handwheel beneath the lever *K* provides for fine setting of the spindle head vertically.

Housed in the right-hand column there are two control panels, and the upper incorporates push-buttons for those functions which are required only infrequently, for example, switching on and off the hydraulic pump. The lower panel is provided with controls for starting and stopping the spindle, selection of direction of rotation, and selection of speed. Between the panels is housed the optical measuring system for the spindle head, also dials for setting dimensions by hand. Immediately beneath the lower panel there is a dial-type control for the hydraulically-operated traverse motions of the table, in the longitudinal and transverse directions, also the spindle head vertically, and speeds can be selected steplessly within the range 0 to 118 in. per min. The two short joy-stick levers to the left of the speed control engage the longitudinal, transverse, and vertical motions, and are of the directional type.

spindle, on the other hand, the distance from the tool to the support point in the head increases progressively as boring continues, and deflection and vibration may sometimes result. A boring stay can be supplied for the new Dixi machine, if required, and the spindle nose has a bayonet-type fixing for quick-change tool-holders, also a flange whereon milling cutters can be mounted.

The spindle head is raised and lowered on the columns hydraulically, and the minimum and maximum distances from the spindle centre to the working surface of the table are 2 and

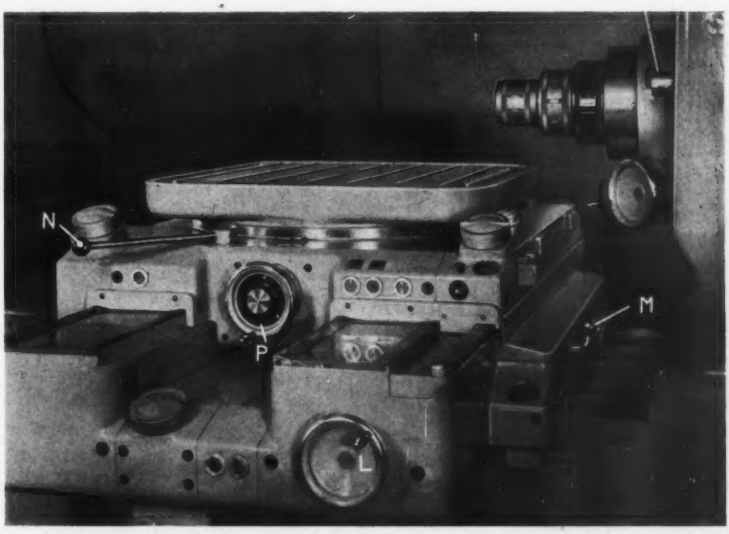


Fig. 5. The work-table is of the rotary type and is provided with transverse movement on a longitudinally-sliding saddle

A close-up view of the compound table, which has a working surface of 32 by 32 in., is shown in Fig. 5. The table portion can be turned through 360 deg., and has a transverse movement of 21½ in., on a saddle member which is arranged for longitudinal movement of 28 in. on the bed. The handwheel *L* provides for manual fine adjustment of the saddle longitudinally, and the lever *M* for locking this motion. Another lever at *N* can be set in three positions, and according to the setting will lock the rotary table only, the rotary table and the transverse motion, or the transverse motion only. The handwheel *P* is interlocked with the lever *N*, and according to the position of the latter serves to turn the rotary table or to apply fine transverse adjustment.

There are separate optical systems for setting the table in the longitudinal and transverse directions, also for the angular setting of the rotary table, and each viewing screen can be illuminated by a push-button. Illumination is maintained for a period of 20 sec., after which it is automatically switched off. The pair of push-buttons immediately to the right of the handwheel *P* controls the power rotation of the table in both directions.

THE VARIOUS CONTROL SYSTEMS

As mentioned earlier, settings of the table transversely and longitudinally, also of the head vertically, can be obtained by various methods. A close-up view of the combined control desk and tape/strip reader is given in Fig. 6, and at the centre can be seen a bank of push-buttons. The ends of these buttons are engraved with numbers, all those in the lowest row bearing the digit 1, those in the next row the digit 2, and so on up to 9. By the use of these buttons, ordinates for each of the three machine movements can be set up successively, as required, and on pressing the start button the machine elements will move to the required positions, and stop.

Alternatively, short punched-paper strips can be prepared—one strip for each ordinate position—and these strips can be fed successively to the reader. The strips can be perforated in a planning office, or can be produced as a by-product of setting with the aid of the buttons described above. Control of the machine by means of a number of short strips offers certain advantages when only a small batch of workpieces is required to be machined. The complete operating cycle does not necessarily have to be predetermined, and apart from pre-setting the ordinates on the strips the operator has considerable latitude with regard to the other functions of the machine. It is stated that in some instances it may even be an advantage to prepare strips for a single workpiece, for example, where a series of operations entails returning the machine repeatedly to a common datum.

Finally, the machine can be controlled automatically, for all functions, by means of endless punched tape, which is prepared in the conventional manner in a planning office. It may be noted that when the machine is operated in this manner, the manual setting buttons on the control desk are still in circuit, and can be employed to insert settings and commands which are additional to those included on the tape. Whichever control system is in use, the optical equipment continues to function, and can be used at any time to check the positions of the main machine members.

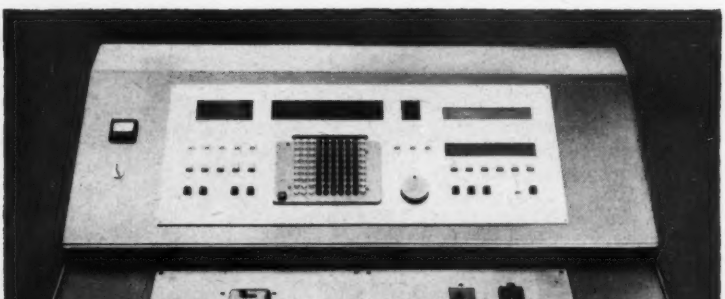


Fig. 6. The combined control desk and tape-reader also incorporates a bank of push-buttons whereon dimensions for the three main machine movements can be set manually

Also provided on the control desk shown in Fig. 6 are buttons for stopping and starting the

spindle, selecting direction of rotation, engaging and disengaging rapid traverse movement of the slides, and selecting and engaging the required spindle speeds and feed rates. Signal lights, illuminated in response to perforations in the tape, warn the operator when tool-changes are necessary, as determined by the planning office, and the tape feed is automatically stopped if one of these lights is on.

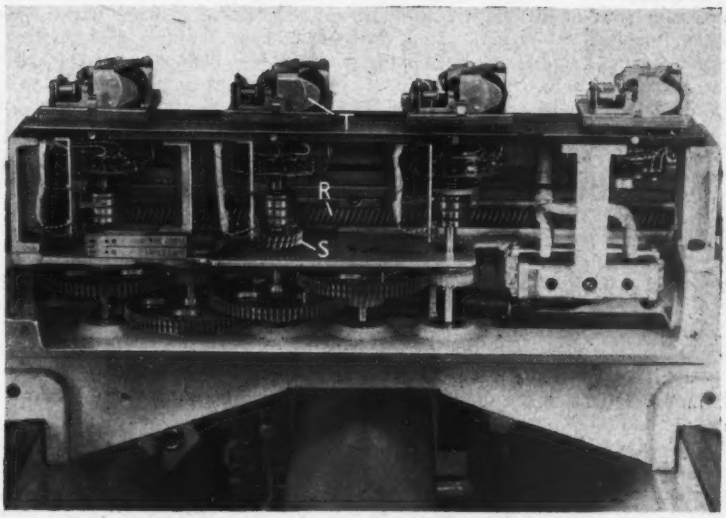


Fig. 7. Close-up view, with covers removed, of the coarse-positioning system for transverse movement of the work-table on the saddle

THE COARSE-POSITIONING SYSTEM

A close-up view of the coarse-positioning-monitoring system for the transverse motion of the table on the saddle is given in Fig. 7. Attached to one edge of the table there is a helical rack, as at *R*, which meshes with a pinion housed in a gearbox secured to the saddle. This pinion acts as an idler, to transmit drive from the rack (as it moves with the table) to a gear S, and the latter—also the idler pinion—is of the split-type, so that backlash can virtually be eliminated from the transmission. The gear S is secured to a vertical shaft, at the upper end of which there is a special contact drum. A large and a small gear at the lower end of the shaft serve to transmit drives, at the required ratios, to vertical shafts at either side. These shafts also have contact drums at their upper ends. The speeds of the shafts are in the ratio of 10 to 1, and the fastest makes one complete revolution for each 10-mm. movement of the slide. Since the fastest slide movement is 3,000 mm. per min. (118 in. per min.), the top speed of this shaft is only 300 r.p.m. It may be noted that all gears in the train from the centre shaft are of the split type, in order that backlash can be reduced to the minimum.

Each contact wheel operates in conjunction with contact fingers which are arranged for angular adjustment by small units as at *T*, and the angular positions of the fingers are determined in response to signals from the control desk, either by way of the settings of the push-buttons or by the punched-tape. The slide will continue to move until each of the contact wheels has turned sufficiently to complete a circuit with its associated contact finger, and with this arrangement, it is stated, the slide can be brought to within 0·2 mm. (0·008 in.) of the required position.

THE FINE-POSITIONING SYSTEM

The fine-adjusting system, whereby the slide is brought to its final position, is of the optical type, and use is made of the precision scales which are provided for visual setting. With this system, which comes into operation automatically, an image of the scale is projected, through a graticule, on to an electronic counting tube, and the graticule is provided with fine lines at a spacing of 100 per mm. The coarse positioning system has already brought the image of the required division on the scale into the field of the counting tube, and the tube counts the required number of graticule lines. A process termed "electronic shift" is incorporated to permit sub-division of the graticule line spacing, to increase the accuracy of the system.

Assuming that the dimension 347·286 mm. is required, then the system will operate in the following manner. The image of the 347th division on the scale will be brought into the field of the counting tube under control of the coarse system, and the fine system will add 28 lines on the graticule (at a value of 0·01 mm. each) and

electronic shift of the graticule will be applied to obtain the final 0·006 mm. It is stated that the equipment is capable of positioning a slide to within ±0·001 mm. (±0·00005 in.). When the required position has been reached, it is allowed to remain undisturbed for 2 sec., before the hydraulic clamps are automatically applied. The clamps are of the self-sustaining type, so that they remain applied even in the event of a failure in the hydraulic supply.

Canning Automatic Plating Plant for Wheel Rims

A new plating plant, stated to be the first of its type in this country, has been supplied by W. Canning & Co., Ltd., Great Hampton Street, Birmingham, 13, to the Coventry works of Triumph Engineering, Ltd. This special Trojan hydraulically-operated return-type unit is employed for the nickel and chromium plating of wheel rims for Triumph motor cycles, and a view from the control console end is given in the accompanying illustration. Other items such as kick-start levers, silencers and brake levers, can also be handled, with the aid of suitable jigs.

There are two sections, and the first, which incorporates the cleaning and chrome-plating tanks, also the rinsing tanks, is of standard Trojan design, whereas the second is the specially-designed nickel section. This section operates on the multiple-cell plating principle, the work being set down in one of eight different sections or cells, with the rims held horizontally in a jig, and surrounding a fixed central core of nickel anodes. Since the work is stationary during plating, the anodes can be positioned so that the most efficient current distribution is obtained.

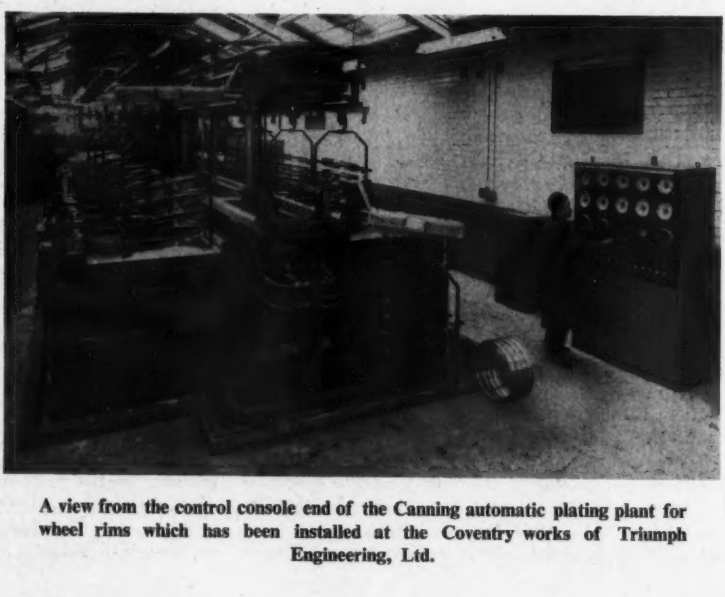
The work jigs are carried on special arms that are raised and lowered to immerse the work in the tanks, and the arms are engaged by solenoid-operated pawls on an overhead transfer chain for movement from one section to the other. An indexing switch determines the loading sequence of the nickel plating tanks, and energizes the solenoid-operated lifting and lowering pawl at the vacant position.

The plating jigs are loaded and unloaded manually by one operator, and additional hooks are provided on the arms to enable standard-type plating jigs to be used in place of those provided for the rims.

For the acid etch process, the work is immersed for 2½ min., but the rectifier, which is controlled by a timing device, is only switched on for the final 45 sec. In this manner, an evenly etched surface, without any pickling effect, is obtained before the voltage is applied.

Appreciable economies in nickel consumption have resulted from the method of plating employed. Previously, the rims had to be "overplated" to ensure that the spoke band received a sufficient thickness, and the deposit on the rim beads was four times as thick as that which was deposited on the band.

This ratio has been substantially reduced, and the ductility and adhesion of the deposit have been improved. For an output of 40,000 rims with the new equipment, it is stated that the total number of rejected workpieces has been maintained at a value of less than 0·1 per cent.



A view from the control console end of the Canning automatic plating plant for wheel rims which has been installed at the Coventry works of Triumph Engineering, Ltd.

"Times" Machine Tool Demonstration

Times Machinery Co., Ltd., in collaboration with their associates, Frye Machine Tool Co., Ltd., and Sheet Metal Machinery Co., Ltd., are now staging demonstrations at their showrooms at Poyle Road, Colnbrook, Slough, Bucks., of some of the Continental-built machine tools for which they are the selling agents in this country.

A longitudinal travel of 21⅝ in. and a cross movement of 13¾ in. are provided for the 31½- by 17¾-in. work-table on the Fimap Olympia (Italian) jig borer shown in Fig. 1, which is available for demonstration, and co-ordinate settings are made with the aid of a built-in optical system. This system gives a magnification of 20×, and readings to 0·0001 in. are observed on two circular dials housed beneath a hinged cover at the front of the cross-slide. Drive is taken from a 2-speed motor of 1¼/2½ h.p., fitted with an electro-magnetic brake, and spindle speeds can be varied steplessly from 40 to 2,100 r.p.m. under the control of push-buttons on the cross-slide, settings being made with reference to a tachometer mounted at the top of the column. The spindle head can be adjusted by hand for a maximum distance of 17¾ in. on the column guideways, and the spindle travel is 6¾ in., the maximum distance obtainable between the spindle nose and the top surface of the table being 25 in. There are four rates of power feed, which range from 0·0008 to 0·005 in. per rev.

In Fig. 2 is shown the new Hydroplan 35 automatic spinning and flow turning lathe introduced by Karl Keilinghaus Werkzeug und Maschinenfabrik, Ahlen, West Germany. This machine will handle blanks up to 32 in. diameter, with maximum thicknesses of 0·16 in. for mild steel, 0·1 in. for stainless steel, and 0·26 in. for aluminium, and a number of passes up to a maximum of eight can be taken on the work, during a fully automatic cycle, for copy spinning. Templates for controlling the forming slides during the individual copy spinning passes are mounted one above another to form a stack, which is supported above the cross-slide by brackets at the ends of the longitudinal guideway member. At the beginning of the working cycle, a stylus pin on the cross-slide is raised to its maximum height, to engage with the topmost template for the first copy-spinning pass. For the next pass, the stylus pin is automatically lowered to make contact with the second template, and this sequence is repeated until the entire cycle has been completed. During the final pass, which is carried out under the control of the lowest template, the workpiece is brought into close contact with the forming chuck mounted on the headstock spindle throughout the full length. After the forming roll has been brought clear, the tailstock barrel is retracted, and a plunger built into the headstock spindle is advanced to eject the completed workpiece from the chuck.

Copy spinning may be started at the headstock or the tailstock end of the work, and the number of passes to be taken during the working cycle can be pre-set by a selector switch built into a control panel on the front of the bed. Spinning may be performed during the return movement of the longitudinal slide, if required, and the stylus pin may be lowered into contact with the next template in the stack at either end of the stroke. Movements of the longitudinal slide for the individual spinning passes are controlled by separate stops which can be adjusted independently in a slotted carrier.

The longitudinal slide has a maximum movement of 17½ in., and the cross-slide a travel of

Fig. 1. This Italian-built Fimap Olympia jig borer incorporates optical setting equipment

L2

Fig. 2. A maximum of eight copy spinning passes can be taken on the work at a fully-automatic cycle on the German-built Hydroplan 35 machine here shown

7½ in., and steplessly-variable traversing speeds from 0 to 130 in. per min. are obtainable. Movement is imparted to the cross-slide by a hydraulic cylinder, and to the longitudinal slide by a hydraulic motor through a screw and nut. End thrust on the traversing screw is taken by roller bearings, and the longitudinal slide is mounted on vee and flat guideways.

Fitted with a 4¾-in. diameter pressure plate, which is mounted on roller bearings, the hydraulically-operated tailstock barrel has a maximum travel of 24 in., and enables a force up to 2·3 tons to be applied to the work. The ejector plunger, which has a travel of 10 in., is fitted with a ball-bearing mounted pressure head, and enables work to be thrust off the spinning chuck under a maximum force of 1½ tons.

Main drive is taken by V-belts and gearing from a 10-h.p. pole-changing motor, and 8 spindle speeds are available, ranging from 135 to 1,340 r.p.m. A d.c. braking system is incorporated for quickly stopping the headstock spindle. Fluid is delivered to the hydraulic system at a maximum pressure of 950 lb. per sq. in. by a gear pump which is driven by a 6-h.p. motor.

The Hungarian-built type E 400 centre lathe, illustrated in Fig. 3, will swing a maximum diameter of 15¾ in. over the bed-ways, and 8¾ in. over the saddle, and a maximum of 39⅜ or 59 in. can be accommodated between the centres, depending upon the length of the bed. A detachable bed-piece is provided, and when it is removed, diameters up to 23 in. can be swung in the gap. Drive from a motor housed in the base is taken by a belt to the all-geared headstock, and thence to the spindle by a centrifugal clutch. Twelve spindle speeds are provided which may range from 25 to 1,120 or 33⅓ to 1,500 r.p.m. Mounted in adjustable plain bearings, the headstock spindle is bored 1$\frac{3}{16}$ in. diameter, and will take a No. 4 Morse taper shank. The quick-change feed gearbox enables a total of 81 Whitworth and metric threads to be cut, the former ranging from 240 to 3½ per in. and the latter from

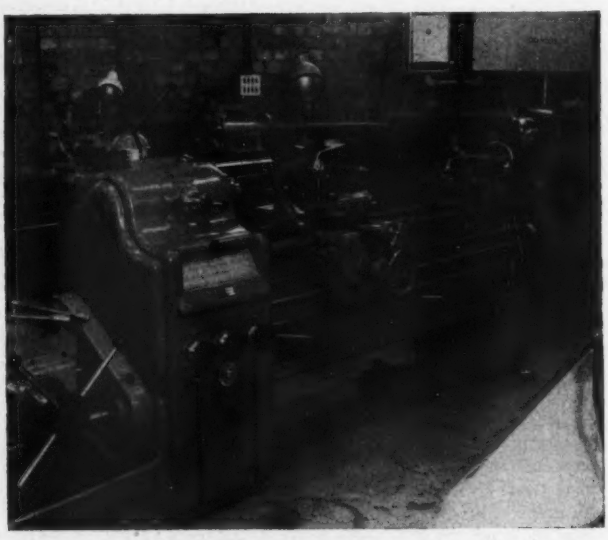


Fig. 3. Hungarian-built type E 400, 15¾-in. swing centre lathe

0·062- to 30-mm. pitch. The sliding feeds available range from 0·0005 to 0·23 in., and the surfacing feeds from 0·0002 to 0·115 in. per rev.

Hungarian-built vertical milling machines which were shown included the latest type VF 222 and the small-capacity type MF 1000. The type VF 222 machine has been developed from the type VF 22, and a feature of the design is that a single lever on the front of the knee controls engagement of the feed and rapid power traverse longitudinally, transversely, and vertically in each direction, starting, and stopping of the spindle, and selection and engagement of the spindle speeds. Feed and rapid traverse motions in the longitudinal, transverse and vertical directions are selected by a knob on the front of the knee, and there is a second knob for reversing the spindle drive.

When the control lever is moved in a direction towards the table and held in this position, a dial for indicating spindle speed is indexed hydraulically through a ratchet and pawl. Upon release of the lever, when the desired spindle speed is shown on the dial, gear changing is effected automatically by hydraulically-operated forks. At the same time, the main driving motor is momentarily switched on to enable the gears to be brought smoothly into mesh. Full particulars of the hydraulic system, as applied to the type VF 22 machine, were given in MACHINERY, 93/214—23/7/58.

On the latest machine, a number of feed and rapid traverse motions can be applied to the table in the longitudinal direction successively, under the control of micro-switches operated by adjustable stops, and a backlash eliminator is provided, to permit climb milling to be carried out. The table has a working surface of 65 by 15¾ in., and traverse movements of 47¼ in. longitudinally, 11⅛ in. transversely, and 15¾ in. vertically are provided. There are 20 spindle speeds from 19 to 1,500 r.p.m., and 18 feeds which range from 0·39 to 19·68 in. per min. Rapid power traverse, at the rate of 79 in. per min., is derived from a separate motor.

Illustrated in Fig. 4, the type MF 1000 machine has a 39⅜- by 7⅞-in. work-table, that can be traversed for a maximum distance of 25$\frac{3}{16}$ in. by hand and 24$\frac{13}{16}$ in. under power feed. A total of 13 feeds, also rapid power traverse, are provided by a motor-driven gearbox built into the knee. Traverse movements of 8⅜ in. for the cross-slide, and 14¾ in. for the knee are provided by hand. The cutter head can be swivelled through an angle of 45 deg. in either direction, and the spindle has 2⅜ in. of axial adjustment. A maximum distance of 14¾ in. is obtainable between the spindle nose and the top surface of the work-table. Drive to the cutter head is taken from a 3-h.p. motor, and spindle speeds range from 63 to 2,800 r.p.m.

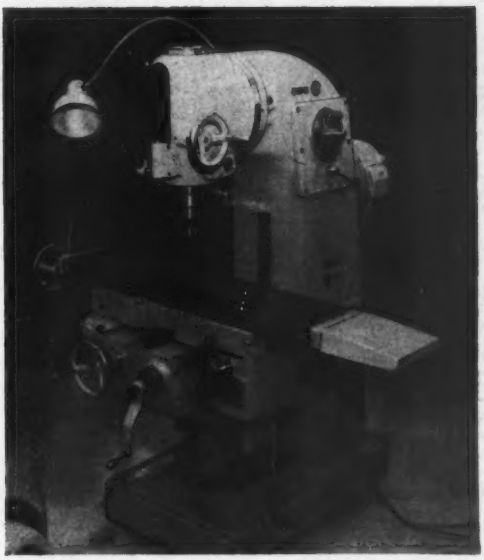


Fig. 4. Table feeds and rapid power traverse movements on this Hungarian type MF 1000 vertical milling machine are provided by a motor-driven gearbox in the knee

Exhibits also included a Czechoslovakian-built type SU 63 A centre lathe, which has a swing capacity of 23¾ in. over the bed-ways, and 14¾ in. over the cross-slide, and will accommodate from 49 to 279 in. between the centres, depending upon the length of the bed. Drive is taken from a 2-speed, pole-changing motor, and 30 spindle speeds from 8 to 375 r.p.m. are available, in two ranges. Two hydraulically-operated brakes are fitted, one of which acts on the headstock spindle, and the other on the first motion driving shaft. The feed gearbox enables a wide range of screw threads to be cut, and drives to the leadscrew and feed shaft are engaged by multiple-disc clutches which are operated by a hydraulic cylinder. Rapid power traverse for the saddle and cross-slide is provided by a separate motor, and movements in the various directions are engaged by separate push-buttons.

It may be noted that this demonstration will remain open until December 9, instead of December 2, as was originally planned.

The British Association of Machine Tool Merchants

In the report made on behalf of the Council to the 21st annual ordinary general meeting of The British Association of Machine Tool Merchants, Lennox House, Norfolk Street, Strand, London, W.C.2, held on November 28, it was pointed out that during the past year industry had again had to contend with "the now annually recurring phases of assurances of economic stability to be shortly followed by a steep increase in Bank Rate coupled with stringent credit restrictions." These measures, moreover, had been linked to exhortations for increased production and an advance in exports. It must be evident, however, that increased production at a cost which would enable industry to compete in world markets could only be achieved by long term planning, and how could such planning be carried out "in present-day conditions of vacillating economy?"

It was necessary, the Council went on to suggest, that the good of the country as a whole should be put before political aspirations, and that the people, and industry in particular, should be given "the full and true picture of the present situation." On the subject of taxation it was urged that there should be adequate provision for depreciation coupled with realistic investment allowances even though such an arrangement might not be in the best interests of all sections of the machine tool merchanting trade.

The Council regretted that there had been little improvement, in manufacturer/merchant relations during the past 12 months. The remarks on the subject made by the president of the Association (Mr. Walter E. Norton) following the previous annual general meeting had been widely reported, and it was not proposed to repeat them, the Council wished, however, to confirm "their full agreement with the views put forward."

Mr. C. Oldfield

Mr. G. B. Blackburn

Although negotiations were certain to be long and difficult, it appeared inevitable that Britain would ultimately join the Common Market, and here again it was hoped that the Government would keep industry informed of progress "so that future planning may be made in the light of a full knowledge of the implications." In the event of Great Britain becoming a full member, the industry would "have to face up to very real competition from Germany and Italy." Relations existing between European manufacturers and British merchants had "long been most co-operative and the removal of trade restrictions and tariffs should give a real stimulus." It was hoped that this competition might "lead to better relations between manufacturers and merchants in Great Britain, to their mutual benefit."

Attention was also drawn to renewed efforts which were being made to obtain representation for the Association on the Machine Tool Advisory Council.

At the meeting, Mr. C. Oldfield, of C. & G. Oldfield, Ltd., was elected president, and Mr. G. B. Blackburn, of William Watts, Ltd., vice-president for the coming year.

At the annual general meeting luncheon, which was held at the Waldorf Hotel, London, the toast of "The Guests" was proposed by Mr. Blackburn, and The Rt. Hon. Lord Mills, K.B.E., responded. He recalled that he had attended the first meeting of the Association and suggested that it was time that Government Departments realized that this precocious child had now come of age. The work done by members, he went on to stress, was of vital importance to the national economy. On the subject of hire purchase, Lord Mills pointed out that it was now one of the facts of life, and he suggested that the time had come to decide what was right for the country and to stick to it.

Mr. J. R. T. Gibson Jarvie, deputy chairman of United Dominions Trust, Ltd., and chairman of Finance Houses Association, Ltd., then proposed the toast of "The Association." He first referred to the situation that would arise if this country joined the Common Market and emphasized that extra effort would be necessary if we were to hold

our own in the face of the increased competition that we should encounter. In this respect we must show that we meant business by doing business, and not look to the Government to solve our problems.

The fact that replacement of machine tools in the past had been too slow might not have been the fault of the machine tool builder or dealer, but of the financier. The form of financial assistance previously offered had not been very suitable for machine tools, but better facilities were now available.

Responding to the toast, Mr. Oldfield mentioned that in 1950 the total deliveries by the British machine tool industry were valued at £40 million, of which exports accounted for £16¾ million, whereas imports amounted to £5¾ million. Ten years later, in 1960, deliveries had risen to £95 million, exports to £29 million, and imports to £23¾ million. It would thus be seen that the proportion of imports to exports has risen from about 35 per cent in 1950 to more than 80 per cent in 1960. During the first six months of this year, moreover, exports amounted to £17 million and imports to £15½ million. Of this latter total a large proportion came from the Continent of Europe and it was evident therefore that Britain was already becoming a "common market" for Continental machines. There was surely no need to dwell on the possible increase in imports when machine tool builders in Europe were competing with us on equal, and in some cases on unequal terms, with no restrictions in the form of quotas or tariffs.

How were we to increase our exports, as increase them we must? He was sure that everyone in the room knew the answer, but it appeared that very little was being done about the matter. There were three problems, namely, shortage of skilled labour; lack of incentive at all levels, and the difficult relationships which existed between employers and employees.

The shortage of skilled labour, he thought, could be largely overcome if the ratio relating the number of apprentices to the number of skilled craftsmen in the machine tool industry could be modified. Mr. Oldfield also suggested that it was wrong to compel a young man who wished to be a machine operator to serve an apprenticeship of five years when he could easily learn all that it was necessary for him to know in three years. On the other hand, we should try to recapture the pride in apprenticeship for a craft, and ensure that the skill, hard work, and technical achievement were suitably rewarded.

The problem of labour relations was by far the most important facing industry to-day, and if the required spirit was to be achieved there must be a combined effort on the part of the Government, the trade unions, and industrial leaders. Andrew Carnegie had once likened capital, brains, and labour to the legs of a 3-legged stool, and he appealed to these elements to join together to provide a solid support for industry in the future.

Trade Publications

LANDIS MACHINE CO., Waynesboro, Pennsylvania, U.S.A.—Illustrated Bulletin No. E-104 describing the Hy-Duty thread-rolling and forming machine which has an in-feed capacity of 6 in., and a through-feed capacity of 4 in. nominal diameter. (Sales of these machines are handled in this country by Alfred Herbert, Ltd., Coventry.)

MIDLAND SILICONES, LTD., 68 Knightsbridge, London, S.W.1.—Fully illustrated 24-page booklet, entitled "Silicones in Electronics," which is concerned with encapsulating, impregnating, filling and coating materials, fabricated insulating and structural components, and the use of silicones as aids to production.

ELCONTROL, LTD., Wilbury Way, Hitchin, Herts. Data Sheet FSP3, issue 1, describes a flame failure control unit for use with many types of domestic and industrial oil burners. Data Sheet FS, issue 3, is concerned with an improved FSM range of industrial flame failure and burner control units. Sections are devoted to flame detection, types of control unit, types of flame detector, types of enclosure, and complete burner control panels.

CEMENTATION (MUFFELITE), LTD., Hersham, Walton-on-Thames, Surrey. Informative and well-presented booklet entitled: "Machine Mounting in the 20th Century." This booklet is concerned with the Barrymount system of machine mounting and its applications and includes sections on the elimination of vibration and structure borne noise, vibration isolation, machine siting and levelling, and damped spring insulators.

MANDOVAL, LTD., Barrington House, 59 Gresham Street, London, E.C.2.—40-page publication entitled "The Vermiculite Handbook," which describes the properties and applications of this lightweight, inert, insulating material. It is employed in plasters, concrete, and in loose-fill applications for fire protection and heat insulation. The company, which supplies crude vermiculite, is under the management of the Rio Tinto Mining Group.

A. CAPP & SON, LTD., Verdict Gauge Works, Thames Road, Crayford, Kent.—Well-produced and fully-illustrated catalogue of 64 pages describing the wide range of Verdict precision dial test indicators. This third edition includes details of the Repeta, Verdict and Junior ranges, also of height gauges, test sets, and a variety of special gauges. In addition, reference is made to the Verdict OB electronic gauge and to the Verdict-Dow precision mechanical comparator. Spare parts for the various gauges are listed, with prices.

NEWS OF THE INDUSTRY

London and the South

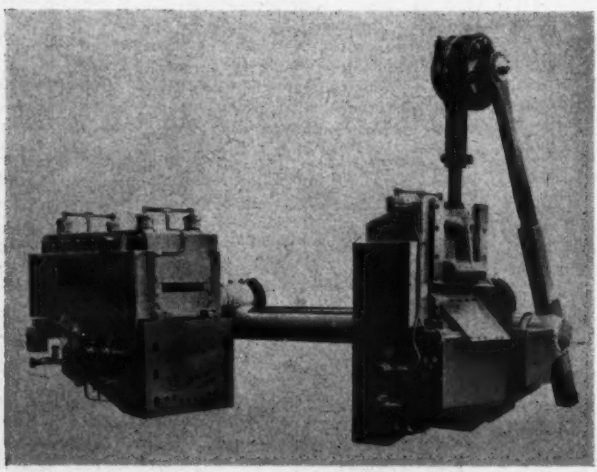
F. J. EDWARDS, LTD., 359-361 Euston Road, N.W.1, are experiencing a very good demand for a wide variety of machine tools and sheet metal working machinery. The latter includes press brakes, guillotines, bending rolls, and machines for nibbling, notching, joggling and shearing. Increasing interest is reported in Trumpf nibbling machines which are available in three sizes and are designed to cut plate up to 0·16 in. thick. With these machines a copy-nibbling technique can be employed to enable internal and external shapes to be cut from master templates without special tooling. For circular blanks, also circular or rectangular cut-outs, templates are not required.

Edel turret presses can now be supplied with co-ordinate setting work-tables, template tables, and other positioning devices. The number of punching stations normally ranges between 12 and 40 but variations in standard designs can often be made to suit individual needs.

We understand that many customers are taking advantage of the F.J.E. machine hire plan in order to equip their shops with machine tools without depleting capital reserves. A large selection of machines is usually in stock at the company's warehouse at Islington Park Street, London, N.1.

HUMPHRIS & SONS, LTD., West Quay Road, Poole, Dorset, are still very busy in all departments and have numerous orders in hand for coiled stock handling equipment, including motor-driven reels for coils of exceptional weight. Owing to the wider use in industry of thicker steel strip in coil form, the company has paid increasing attention to the design and construction of machines for decoiling, feeding and levelling such material.

A recent example of Humphris levelling and feeding equipment provided with outgoing feed rolls and a scrap cutter is shown in the accompanying illustration. The seven hardened and ground, gear-driven levelling rolls are mounted in needle roller bearings which are supported in Meehanite housings, and controls are provided for the adjustment of the top rolls. Pressure is applied to the top feed rolls pneumatically and an automatic lifting device is provided, which is controlled by a limit switch at the press station. Steplessly-variable feed up to 12 in. pitch is derived from the press and transmitted to the feed rolls through gearboxes and special couplings. The rolls are provided with spring-tensioned brakes which are released by air cylinders also controlled by limit switches at the press.



Humphris combined levelling and feeding equipment, with outgoing feed rolls and a scrap cutter, for the thicker grades of steel strip which are being more widely used in industry

It may be noted that the company specializes in cut-to-length lines for the production of large transformer core laminations. The length measuring system employed in such installations is electronically controlled and is stated to be exceptionally accurate at high speed.

EXPRESS TOOLS, LTD., Roebuck Road, Chessington, Surrey, are still fully occupied with orders for press tools for the production of a wide variety of parts to close tolerances, including small gear blanks, components for calculating machines, and

perforated chassis for special applications. Form grinding is extensively employed in the production of press tools of the segmental type. A Diaform attachment is available for wheel forming and the profiles of the die members are examined on an optical projector. The larger press tools may weigh as much as 8 cwt. Facilities are provided for making jigs, fixtures and receiver gauges, also for the production of pressings, for which a line of presses, with ratings up to 40 tons, has been installed. Jones & Shipman grinding machines are widely employed, and for jig boring there are two machines, one by Société Genevoise and the other by Hauser.

LUMATIC, LTD., 47 South Street, Epsom, Surrey, who are design consultants and suppliers of equipment for lubrication systems, are steadily expanding their activities in the industrial field. This firm has supplied comprehensive lubrication installations for conveyor systems operating under unusual or difficult conditions, also for processing plant, production lines, and machine tools. Automatic lubricating systems of modern design are rapidly finding increasing favour for machine tool applications, to replace older types of manually-operated lubricators which may require frequent attention.

RAY-HEET (PROCESS PLANT), LTD., Bookham, Surrey, an associate company of Vokes, Ltd., Henley Park, Guildford, Surrey, are as busy as ever with the design and construction of degreasing and rustproofing plant, spray painting booths, infra-red ray type heating tunnels, and ovens for industrial use. The company has recently provided much of the equipment for a mechanized paint finishing installation for commercial vehicle body and chassis parts for the factory of Ford Motor Co., Ltd., at Langley, Bucks. Parts for more than 120 vehicles can be processed daily by the plant which comprises 12 spray booths of various types; five large convection ovens, one steam heated and the others fired by propane piped from bulk storage; and an automatic paint dipping line .

Chassis for heavy vehicles are carried on a conveyor at floor level through a standard Ray-Heet down-draught paint spraying booth and are transferred to an oven for an 8-min. drying cycle. Axle assemblies, suspended from an overhead conveyor, are sprayed when in transit through a wet-back Ray-Heet booth 48 ft. long. Smaller items, including, for example, front wings and instrument panels, are painted in either of two water-wash, down-draught type, spray booths, the larger being 35 ft. long and the other 7 ft. 6 in. long. The 6-stage degreasing and rustproofing plant which, it may be noted, was designed with the co-operation of the Pyrene Co., Ltd., has an overall length of 175 ft. and is served by monorail conveyors. The finish coat oven, which is 70 ft. long by 20 ft. wide and 16 ft. high, is built 8 ft. above floor level, and parts are stoved at a temperature of 250-325 deg. F. in a 50-min. cycle time.

ASHTEAD ENGINEERING CO., LTD., Grove Road, Ashtead, Surrey, are still receiving numerous orders for a wide variety of centreless-ground parts which are produced to close tolerances, on one or more diameters, at set-ups on Scrivener 1 A machines. Founded in 1922, this firm has specialized in centreless grinding operations for more than 22 years and much of the work undertaken is for regular customers, and is produced to A.I.D. and A.R.B. approved standards. Facilities for thread-milling for the trade are also provided, and threads up to 3 in. diameter can be cut by this process, if required. F. W. HERRIDGE.

Shell Film on Oil-engine Evolution

At a time when the manufacture of internal combustion engines of all types is assuming increasing importance to the metal-working industries of this country, and in particular when compression-ignition engines are gaining widespread acceptance for railway applications, Shell-Mex and B.P., Ltd., Shell-Mex House, Strand, London, W.C.2, have introduced a new film, which is entitled "A History of the Oil Engine".

In making the film, it was the aim of the producers to portray accurately the historical events in oil-engine evolution, and it was decided to use some 400 original drawings, paintings, and photographs, many of which were made available by libraries and museums. The result indicates how an interesting film can be made largely without moving pictures. The sound track provides the noises of the engines and other machinery depicted, and there is a short concluding sequence of moving film in colour, which is concerned with the modern uses of the oil engine.

At the start of the film it is explained that the earliest attempt to produce an internal combustion engine was probably made in the 17th century by the Dutchman, Christiaan Huygens (1629-1695), who designed a vertical engine with a balanced piston. The piston was raised by exploding a charge of gunpowder in the cylinder and the cooling of the gases after the explosion allowed the piston to descend. The power produced during the descent was applied through a system of ropes and rollers to raise a loaded platform. Whereas it was shown that the engine was workable with a single charge of gunpowder, it was not possible to provide a mechanism for delivering the

sequence of charges required for continuous operation.

The film describes the work of such men as Lenoir, Otto, Robson, Priestman, Akroyd Stuart, Diesel, and Buchi. The invention of a fuel pump by James McKechnie in 1910 is considered, also the study of combustion-chamber design by Sir Harry Ricardo.

Produced by Random Film Productions, Ltd., the film runs for 33 min. and is available free on loan, in 35- and 16-mm. sizes, on application to any of the divisions of Shell-Mex and B.P., Ltd.

Sykes Apprentice Prizegiving

W. E. Sykes, Ltd., recently held an apprentice prizegiving at Manor Works, Staines, and the guests, who numbered 130, included parents of apprentices, headmasters and careers masters of local schools and technical colleges, and youth employment offices from the district. Mr. G. Jenkins, works director of the Sykes Group, reviewed the progress of the apprenticeship scheme, and drew attention to the opportunities open to the trained technologist and craftsman in the rapidly expanding machine tool industry. The programme also included a talk, illustrated with colour slides, on the company, its history and products, and the apprentice training scheme.

Prizes were presented to 20 apprentices by The Lady Trefgarne, including awards to six who had attained the Ordinary National Certificate, and two the Higher National Certificate in production engineering. Awards were also made for practical ability and for exceptional achievements in various other academic courses. In addition, certificates were presented to nine apprentices who completed their training this year.

The Lady Trefgarne presenting to Mr. J. Payne a completion of apprenticeship certificate, and a prize for attaining the Higher National Certificate in production engineering

It may be recalled that in 1958 the company made arrangements to extend the existing apprentice scheme and appointed a full-time instructor. At the same time, a separate training school was provided, with facilities for both practical and theoretical training.

At present, more than 75 apprentices in the craft, engineering, and student categories are under training.

Developments in Programming Methods for Numerical Control

(*Continued from page* 1295)

From the hand-written programme sheet, the information is transferred to punched cards which are subsequently fed into the computer, whereby the detailed instructions for the control of the tool path throughout the machining cycle are prepared. These instructions, it may be noted, can be finally presented in a form suitable for the control system applied to the machine on which the operation is to be performed. As an indication of what can be accomplished with this technique, it is stated that the programme for machining from the solid a complex cover for a helicopter gearbox, when written from the blue-print comprised only 180 single-line statements. From this programme, the computer provided more than 8,000 tool path instructions, to cover the entire sequence of machining operations. It may also be noted that the computer is able to detect, and to indicate by printed reports, many types of errors which may occur in the part description.

With the facilities afforded by this system, it would appear that the work involved in programming will often be considerably reduced. In addition, the straightforward nature of the procedure should afford encouragement to an increasing number of companies to investigate more fully the possibilities of numerical control in three dimensions, for die sinking and similar operations. It is evident that what is more urgently required at the moment is not further development of numerically-controlled machines but wider exploitation of those that are already available.

E.I.A. One-day Display in Manchester

The North West Region of the Engineering Industries Association organized a one-day display of engineering products and processes at Belle Vue, Manchester, 12, on November 21, in which 55 firms, mainly from the Manchester area, partici-

pated. Intended to afford an opportunity for member-firms to show their products at small cost, the event, which was well-attended, enabled the visitor to see and discuss, for example, machine tools, cutting oils, counting equipment, castings in a variety of metals, wire components, lubrication equipment, plated components, mechanical handling plant, and jigs and fixtures. One stand was concerned with the Association's group apprenticeship scheme, and examples of apprentices' work were on show. Another stand was occupied by the Association, and publications were displayed which have been prepared to assist firms in the solution of problems relating, for instance, to taxation, pensions, apprentices, and various financial aspects of business.

In his opening address, Mr. Bertram Mycock, industrial correspondent of the B.B.C. spoke of the important part played by the Association in industry to-day, particularly as regards the exchange of information among members, and of the efforts that were made to solve individual problems as well as those facing the engineering industry as a whole. In the absence through illness of Lord Davidson, president of the Association, the director general, Air Commodore L. E. Jarman, was present.

The address of the North Western Region offices of the Association is 178 Corn Exchange Buildings, Fennel Street, Manchester, 4, and the secretary is Mr. G. Aplin.

Industrial Notes

STANHOPE MACHINE TOOLS, LTD.—The address of this company is now 12-14 Wigmore Street, London, W.1 (telephone Langham 8408: telegrams, Stanmatic, Wesdo, London).

PRODUCTION OF IRON CASTINGS in the third quarter of this year amounted to 845,900 tons, as compared with 903,710 tons in the corresponding period of 1960. For the nine months ended September 30, the total was 2,879,060 tons, as against 2,942,880 tons in 1960.

TRETOL, LTD., The Hyde, London, N.W.9, have introduced a heavy-duty grade of Tretol Epiflor oil- and acid-resistant floor topping, which is intended for use in factories, plating shops, and garages, where the floor must withstand exceptionally hard wear from trucks.

ADREMA, LTD., Telford Way, London, W.3, inform us that their Type Department is now operating in rebuilt premises that provide a floor area of 3,000 sq. ft., which is double the space previously available. The staff has also been doubled. This department produces hardened steel type faces and matrices for Bradma plate-embossers.

EDGAR ALLEN & CO., LTD., Imperial Steel Works, Sheffield, 9, have held a minority interest in the Sheffield Hollow Drill Steel Co., Ltd., for many years. They have now acquired the remainder of the issued capital and the company has become a wholly-owned subsidiary within the Edgar Allen Group.

UNION CARBIDE, LTD., Flame Plating Department, by arrangement with John Harris Tools, Ltd., Millers Road, Warwick, have taken over responsibility for operating the flame plating process, from the same address. John Harris Tools, Ltd., will continue to sell flame plated screwing tools and gauges. It is anticipated that in the near future it will be possible to offer the full range of coatings available in the U.S.A., including aluminium oxide, in addition to the tungsten carbide coatings already available.

F. J. EDWARDS, LTD., 359-361 Euston Road, London, N.W.1, are now sole representatives in the United Kingdom for Ludwig Lang tube bending machines. The range includes the mandrel type EL general purpose machine with electro-mechanical drive for tubes up to 3 in. outside diameter by 14 s.w.g.; the electro-hydraulic Uni-Gigant machine, also of the mandrel type, for tubes up to 6¾ in. outside diameter; and the Robima electro-hydraulic machine for tubes or pipes up to 10 in. outside diameter, also solid bars and sections.

STANDARD TELEPHONES & CABLES, LTD., are to lease a 50,000-sq. ft. advance factory, built under the Northern Ireland Industrial Development Plan, for the production of telephones and telephone exchange equipment. The factory, which is at Monkstown, near Belfast, is ready for immediate occupation, and another will be built for the same company by the Ministry of Commerce on the same estate. It is stated that the second factory will have an area of 150,000 sq. ft., and will eventually be expanded to double that size.

Coming Events

INSTITUTION OF PRODUCTION ENGINEERS. *Doncaster Section.* December 12, at 7 p.m., at the Technical College, Waterdale, Doncaster; lecture on "Continuous Casting," by G. Littlewood. *Lincoln Section.* December 13, at 7.30 p.m., at Lincoln Technical College; lecture on "The Production Engineer—Today and Tomorrow," by F. W. Cooper. *Liverpool Section.* December 13, at 7.30 p.m., at the Central Library, William Brown Street, Liverpool: lecture on "The Production Engineer's Approach to Domestic Appliance Manufacture," by V. J. Adams. *Reading Section.* December 14, 7.30 p.m., at Farnborough Technical College, Boundary Road, Farnborough; lecture on "Practical Applications of Production Engineering Research," by Dr. D. F. Galloway, B.Sc., M.I.Mech.E., M.I.Prod.E.

INSTITUTION OF MECHANICAL ENGINEERS. *Education and Training Group.* December 18, at 6 p.m., at the Institution, 1 Birdcage Walk, Westminster, London, S.W.1; discussion on "The Teaching of Machine Tool Technology as an Academic Subject."

INSTITUTION OF ELECTRICAL ENGINEERS. *Irish Branch.* December 14, at 6 p.m., at the Physical Laboratory, Trinity College, Dublin; paper on "Production of Electric Motors in Ireland," by L. O'Sullivan, B.E.

THE INSTITUTE OF METAL FINISHING. *Sheffield and North-east Branch.* December 15, at 7 p.m., at the Grand Hotel, Sheffield; paper on "Plating of Zinc Base Die Castings," by S. W. Baier.

Rootes Die Casting Plant

It has been announced that a factory for the production of aluminium die castings is to be built at Linwood, Paisley, for Rootes Motors (Scotland), Ltd., and that the buildings, plant and equipment will cost £1,250,000. Of this total, the buildings, which are to be erected by Holland & Hannen and Cubitts, Ltd., will account for £400,000. Construction is to begin immediately and is to be completed by June 11, 1962. The main factory building will be 300 ft. long by 180 ft. wide by 40 ft. high; and there will be a single storey service annexe, also an office and amenities annexe of two and three storeys.

High pressure die casting of aluminium alloys will be undertaken, and in addition to meeting the company's needs in connection with car manufacture in Scotland, there will be capacity for other industrial work. Approximately 500 people will be employed, and the factory is being planned to permit considerable expansion in the future.

New Appointments

The following new appointments have been announced:—

MR. F. DEAN SWIFT, as sales director and MR. G. R. HANDS as marketing director of Wolseley Engineering, Ltd., Wolseley Works, Electric Avenue, Witton, Birmingham, 6.

MR. J. H. KARTZ, as chairman of the Benson Bond Group, and MR. H. MILLER, as managing director of Benson Bond, Ltd., P.O. Box 272, Station Road, Birmingham, 23.

MR. R. C. MILLER, as sales representative for Firth Cleveland Steel, Ltd., for North East England. He will operate from the Holmes Mills, Rotherham, of J. J. Habershon & Sons, Ltd.

MR. R. E. ANSELL, as sales director, and MR. C. BOWLES as sales manager, responsible to the sales director, for Henry Wiggin & Co., Ltd., Thames House, Millbank, London, S.W.1.

MR. ALEC ISSIGONIS, who has been chief engineer of The British Motor Corporation, Ltd., Longbridge, Birmingham, since 1957, as technical director, in succession to Mr. S. V. Smith who has retired.

MR. D. H. BING, of 23 St. Margaret's Gardens, Biggleswade, Beds., as representative for Myford, Ltd., Beeston, Notts., in the London area. He succeeds Mr. F. J. Winter, who has retired after 22 years' service with the company, including some 15 years after normal retirement age.

MR. G. J. HOOPER, as applications manager of D. A. Stuart Oil Co. (G.B.), Ltd., Lincoln Street, Wolverhampton, a wholly-owned subsidiary of the Amber Group. For the past 15 years he has acted as technical specialist on cutting oils with one of the leading companies.

MR. M. A. FUDGE, as director and general manager of The Tenuous Steel Co., Ltd., Rotherham, Yorks. For the time being he will retain the position of company secretary of Firth Cleveland Steel Strip, Ltd., Tipton, Staffs., which he has held since 1956.

MR. F. V. SMITH, as director and general manager of Robert Kellie & Son, Ltd., Dundee, a subsidiary company of Vokes Group, Ltd.

MR. W. A. ABBOTTS, 5 Larkfield Avenue, Castle Bromwich, Warwicks., as technical representative for Electrical Remote Control Co., Ltd., Bush Fair, Harlow, Essex, for Birmingham, and the counties of Salop., Staffs., Derbyshire, Worcs., Notts., Leics., and Warwicks.

MR. JOSEPH SAMUELS, as managing director of Winston Electronics, Ltd., Shepperton, Middlesex. He has been a member of the board for six years. MR. W. ALLAN BRIDGES has relinquished the managing directorship, but continues to hold the office of chairman.

MR. T. S. J. ANDERSON, C.B.E., T.D., M.A., to the newly created position of controller of education and training for Vickers, Ltd., Vickers House, Broadway, Westminster, London, S.W.1. The appointment carries the status of principal officer.

MR. R. SHELTON, as product designer, and MR. R. BRADLEY, formerly chief planning engineer, as manager of the engineering department of Stanley Works (G.B.), Ltd., Rutland Road, Sheffield, 3. Mr. Shelton will be head of a new department responsible for the design and development of new products.

MR. J. R. MEAD, J.P., F.C.A., as chairman, and MR. H. F. HOPE, as managing director of Cornercroft, Ltd. Ace Works, Coventry. Mr. Mead has also been made chairman of the subsidiary James Beresford & Son, Ltd., Birmingham, and Mr. W. J. BURSLEM, managing director of that company.

MR. C. F. WILLIAMSON, as sales manager of the Compressor Division of Tilghman's, Ltd., Broadheath, Nr. Manchester, a member company of the Staveley Group. Recent additions to the sales force include the following compressor specialists: Mr. R. Bushell (Lancashire and Yorkshire), Mr. A. H. Stenning (London), and Mr. J. Smith (North East Coast and Scotland).

Cincinnati Grinders Representation

Cincinnati Milling Machines, Ltd., Kingsbury Road, Tyburn, Birmingham, 24, announce that from January 1, 1962, Charles Churchill & Co., Ltd., Coventry Road, Birmingham, 25, will handle the sales of their range of grinding machines in addition to the Cincinnati milling machines which they have marketed in Great Britain for more than 70 years.

In this connection it should be noted that The Churchill Machine Tool Co., Ltd., following the acquisition of the business by The Birmingham Small Arms Co., Ltd., have terminated their sales agreement with Charles Churchill & Co., Ltd., with effect from December 31.

Vickers Hardness Testing Standard

B.S. 427:1961 Method for Vickers Hardness Test—Part 1, Testing of Metals, which has recently been published, defines the requirements and procedure for the

testing of metals at ordinary temperature. It is restricted to the use of the 136-deg. diamond pyramid, and the requirements are not less exacting than the corresponding recommendations of the ISO. This standard is intended to meet the general needs of industrial hardness measurement of both ferrous and non-ferrous metals with loads ranging from 1 to 100 kg.-force, including the testing of thin sheet metal and strip. Comprehensive tables of hardness values applicable to tests on flat surfaces are included, together with tables of correction factors to be applied when tests are carried out on spherical or cylindrical surfaces.

Part 2 of the Standard, which is now in preparation, will be concerned with the verification of hardness testing machines, and calibration of standard hardness blocks.

Copies of Part 1 can be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1. (Price 15s—postage extra to non-subscribers.)

Scrap Metals

†LONDON.—‡Prices per ton for non-ferrous scrap metals free from iron are as follows:—Clean copper wire, untinned and free from lead and solder, £193; clean heavy copper, untinned and free from lead and solder, £185; copper wire No. 2, £175; clean light copper, £175; braziery copper, £154; gunmetal, £165; brass, mixed, £122; lead, net, £47; zinc, £28; cast aluminium, £80; old rolled aluminium, £92; battery lead, £24; unsweated brass radiators, £98; hollow pewter, £570; black pewter, £450.

MIDLANDS.—Although the general market situation shows a little improvement, a reduction in the demand for tin has resulted in a fall in price of £9 to £10 per ton.

There has been little change as regards copper, and with a fairly steady market scrap values have not varied greatly. For most copper-base materials there are ready buyers, although in this field prices do tend to vary rather widely.

The position as regards metals mainly affected by changing market values is as follows:—

Copper.—No. 2 wire and braziery scrap are still out of favour, but do not appear to be losing any more ground in comparison with the better grades which are remaining reasonably firm.

Brass.—There has been a slight gain in price for good heavy mixed scrap, but merchants' ideas of value vary, depending on markets available.

Gunmetal.—Trade is steady and there has been hardly any change in prices.

Lead.—There has been a recovery from the recent fall of £4 per ton, on account of improved demand, and a slight decline in production, and it is likely that more metal may change hands.

Aluminium.—The market is still weak, and although there has been no further reduction in values, demand has not improved. A fair quantity of scrap is being moved, including some old rolled and cast material and swarf, but it is not easy to find buyers for these grades.

Zinc.—Prices have increased by £3 to £4 per ton. Demand is steady and zinc die casting materials are favoured.

† George Cohen, Sons & Co., Ltd., 600 Wood Lane, London, W.12.
‡ Subject to market fluctuations.

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BRITISH MACHINE TOOL

Exports of New Machine Tools

Countries	Bar and Chucking Automatics		Vertical Boring Machines		Other Boring Machines		Drilling Machines		Gear-cutting Machines		Grinding, Lapping and Honing Machines		Capstan and Turret Lathes		Other Lathes	
	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £
Commonwealth																
India	292 (2)	15,670	—	—	—	—	23 (4)	1,070	—	—	460 (33)	22,343	913 (15)	36,845	620 (10)	40,271
Pakistan	—	—	—	—	4 (1)	357	136 (3)	3,727	—	—	41 (1)	2,207	46 (2)	1,528	—	—
Australia	291 (5)	21,568	—	—	496 (1)	12,482	310 (8)	8,929	—	—	516 (11)	16,823	116 (4)	5,757	884 (46)	28,577
New Zealand	—	—	—	—	33 (1)	3,681	8 (6)	404	—	—	183 (80)	7,111	103 (7)	5,424	386 (32)	13,724
Canada	—	—	80 (1)	5,745	—	—	143 (192)	3,845	—	—	399 (90)	18,563	168 (3)	5,685	465 (27)	16,796
Miscellaneous	—	—	—	—	103 (3)	10,967	135 (39)	5,641	—	—	81 (17)	4,260	13 (2)	1,058	370 (16)	13,762
Foreign																
South Africa	54 (1)	3,237	—	—	63 (3)	2,300	174 (19)	4,475	—	—	308 (19)	10,932	153 (4)	7,073	531 (16)	19,025
Soviet Union	—	—	101 (1)	10,722	—	—	—	—	119 (6)	12,210	314 (3)	25,446	—	—	—	—
Sweden	—	—	—	—	—	—	123 (2)	3,250	—	—	86 (4)	2,882	420 (5)	12,476	11 (1)	931
Norway	—	—	210 (1)	4,150	70 (1)	1,224	10 (15)	398	131 (1)	3,128	—	—	—	—	475 (17)	14,534
Denmark	—	—	—	—	—	—	77 (2)	1,762	—	—	—	—	96 (4)	6,042	28 (2)	1,469
Western Germany	115 (1)	7,293	275 (2)	10,625	1 (1)	45	113 (29)	3,471	—	—	92 (6)	3,108	358 (5)	11,010	799 (40)	43,390
Netherlands	—	—	124 (4)	3,690	—	—	118 (15)	3,157	40 (1)	2,125	319 (9)	9,773	405 (11)	17,013	89 (14)	4,260
Belgium	—	—	—	—	—	—	54 (13)	1,412	—	—	145 (6)	8,632	165 (4)	5,727	706 (4)	9,078
France	41 (1)	2,177	4 (2)	369	300 (3)	16,159	26 (1)	1,766	170 (11)	6,682	747 (14)	30,957	365 (4)	14,557	243 (5)	12,883
Switzerland	—	—	—	—	—	—	97 (4)	4,612	—	—	58 (4)	3,185	245 (12)	16,486	348 (24)	11,261
Spain	149 (3)	12,082	—	—	—	—	198 (3)	4,834	332 (3)	22,003	296 (14)	24,714	30 (1)	2,657	80 (1)	4,665
Italy	130 (1)	7,020	24 (1)	2,401	—	—	2 (2)	165	120 (1)	8,115	1,010 (22)	41,980	270 (3)	13,970	992 (6)	71,283
U.S. America	—	—	—	—	—	—	235 (7)	6,450	—	—	164 (29)	10,687	118 (14)	7,150	616 (31)	18,326
Miscellaneous	—	—	464 (3)	16,823	546 (3)	28,674	968 (175)	33,551	252 (3)	19,896	1,688 (66)	51,774	383 (12)	23,937	2,723 (105)	122,583
Total	1,072 (14)	69,047	1,282 (15)	54,525	1,616 (17)	75,889	2,950 (539)	92,919	1,164 (26)	74,159	6,907 (428)	295,377	4,367 (112)	194,395	10,366 (397)	446,818

Total exports of reconditioned machine tools: Quantity: No., 364; Weight, 18,012 cwt; Value, £62,618.
Total exports of imported machine tools: Quantity: Weight, 1,106 cwt.; Value, £71,996.

Imports of New Machine Tools

Country of Origin	Bar and Chucking Automatics		Vertical Boring Machines		Other Boring Machines		Drilling Machines		Gear-cutting Machines		Grinding, Lapping and Honing Machines		Capstan and Turret Lathes		Other Lathes	
	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £
Sweden	—	—	—	—	58 (1)	3,915	66 (15)	1,735	—	—	185 (10)	24,149	—	—	293 (14)	9,594
Western Germany	123 (3)	10,815	416 (6)	21,252	1,769 (7)	78,667	312 (45)	12,746	369 (4)	23,751	1,900 (61)	91,623	457 (14)	35,151	343 (37)	26,759
France	—	—	30 (1)	1,728	—	—	28 (5)	731	—	—	14 (7)	1,608	60 (2)	3,180	256 (4)	13,599
Switzerland	213 (11)	21,600	463 (3)	38,093	67 (3)	5,524	115 (9)	6,851	23 (3)	3,260	443 (30)	44,874	290 (8)	25,544	1,072 (44)	80,954
U.S. America	553 (6)	40,000	43 (1)	813	—	—	75 (5)	7,542	325 (3)	32,547	1,321 (31)	116,168	788 (3)	61,853	2,207 (45)	149,135
Miscellaneous	26 (1)	1,784	26 (1)	2,117	434 (4)	10,700	778 (22)	16,126	30 (1)	845	1,080 (43)	45,294	376 (5)	17,507	954 (28)	30,189
Total	915 (21)	74,199	978 (12)	64,003	2,328 (15)	98,806	1,374 (101)	45,731	747 (11)	60,403	4,943 (182)	323,716	1,971 (32)	143,235	5,125 (172)	310,230

Total imports of reconditioned machine tools: Quantity: No., 70; Weight, 4,059 cwt.; Value, £63,964.

IMPORTS AND EXPORTS (Classified)

and Parts during July, 1961

Milling Machines		Presses		Sheet-metal Working Machines		Sawing Machines		Screwing and Threading Machines		Planing, Shaping and Slotting Machines		Unit Transfer Machines and Heads		Other Machines		Machine Tool Parts*		Total	
Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt.	Value £	Quantity. Cwt. and No.	Value £
793 (11)	39,752	1,347 (24)	46,776	34 (7)	726	51 (5)	2,009	219 (4)	9,679	1,791 (6)	21,065	18 (3)	720	519 (13)	28,004	1,649	45,782	8,729 (137)	310,712
50 (1)	1,475	—	—	325 (3)	7,271	—	—	—	—	—	—	—	—	—	—	49	5,107	651 (11)	21,672
988 (12)	42,371	1,199 (5)	21,589	11 (4)	574	10 (5)	1,056	119 (4)	6,896	45 (14)	1,279	—	—	57 (5)	6,408	645	38,359	5,687 (124)	212,668
9 (1)	391	642 (8)	10,900	20 (24)	407	6 (2)	264	58 (16)	5,598	70 (5)	1,449	—	—	82 (34)	1,867	178	6,903	1,778 (216)	58,123
332 (7)	14,858	2,315 (12)	64,909	135 (6)	2,761	14 (2)	342	—	—	48 (7)	1,157	—	—	488 (1)	14,295	161	13,436	4,748 (348)	162,392
43 (1)	2,017	85 (14)	1,359	176 (16)	3,941	30 (5)	946	16 (1)	571	61 (6)	1,415	—	—	79 (12)	1,713	275	17,722	1,467 (132)	65,372
174 (3)	3,688	82 (16)	715	269 (11)	5,944	55 (20)	1,205	5 (1)	414	—	—	—	—	277 (11)	10,075	194	10,820	2,339 (124)	79,903
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	534 (10)	48,378
—	—	—	—	1,057 (2)	31,565	—	—	32 (1)	2,749	—	—	—	—	8 (25)	350	206	11,618	1,943 (40)	65,821
—	—	2 (1)	131	—	—	24 (2)	478	14 (1)	915	—	—	—	—	—	—	36	1,300	972 (39)	26,258
—	—	141 (1)	2,759	3 (1)	77	—	—	—	—	—	—	—	—	—	—	24	4,359	369 (10)	16,468
396 (9)	23,328	1,428 (3)	63,488	2 (1)	169	3 (1)	190	32 (1)	2,695	—	—	—	—	133 (5)	6,513	282	21,191	4,029 (104)	196,516
209 (8)	12,065	108 (2)	6,503	50 (1)	1,006	50 (1)	811	—	—	10 (2)	309	—	—	13 (4)	711	316	11,267	1,851 (72)	72,690
3,323 (7)	122,139	5 (3)	149	138 (2)	2,785	—	—	—	—	15 (1)	190	—	—	205 (11)	6,430	139	12,300	4,895 (51)	168,842
267 (2)	16,021	134 (4)	8,259	—	—	238 (2)	6,162	34 (2)	2,333	58 (2)	1,053	—	—	1,026 (7)	63,221	206	15,346	3,859 (60)	197,945
896 (18)	36,409	254 (2)	6,213	51 (2)	3,224	—	—	—	—	12 (2)	232	—	—	325 (5)	25,096	237	11,969	2,523 (73)	118,687
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	32	3,020	1,117 (25)	73,975
570 (3)	27,977	—	—	52 (1)	6,713	48 (3)	1,227	19 (1)	2,293	—	—	—	—	124 (5)	9,075	9	2,083	3,370 (49)	194,302
11 (1)	416	13 (4)	180	—	—	—	—	—	—	63 (1)	2,274	—	—	234 (18)	14,562	138	14,958	1,592 (105)	95,003
1,132 (19)	69,850	1,949 (22)	46,506	2,095 (15)	50,235	61 (13)	2,276	115 (6)	12,714	179 (11)	5,563	—	—	547 (29)	23,617	574	40,872	13,676 (482)	548,871
9,193 (103)	412,757	9,704 (121)	280,436	4,418 (96)	117,398	590 (61)	16,966	663 (38)	46,857	2,352 (57)	35,986	18 (3)	720	4,117 (185)	211,937	5,350	288,412	66,129 (2,212)	2,714,598

Figures in parentheses denote number of machines. * Not including machine tool cutting parts.

and Parts during July, 1961

Milling Machines		Presses		Sheet-metal Working Machines		Sawing Machines		Screwing and Threading Machines		Planing, Shaping and Slotting Machines		Unit Transfer Machines and Heads		Other Machines		Machine Tool Parts*		Total	
Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt. and No.	Value £	Quantity. Cwt.	Value £	Quantity. Cwt. and No.	Value £
280 (8)	14,453	15 (1)	960	199 (8)	7,892	—	—	39 (1)	2,566	8 (6)	518	—	—	10 (10)	1,370	74	5,061	1,227 (74)	72,213
2,002 (26)	118,318	1,323 (18)	56,261	555 (20)	16,989	312 (39)	14,116	60 (33)	6,979	103 (2)	2,886	17 (1)	3,053	1,246 (69)	74,783	997	95,245	12,304 (385)	689,394
551 (10)	24,436	342 (6)	9,372	—	—	6 (2)	457	—	—	—	—	—	—	42 (51)	5,241	83	8,919	1,412 (88)	69,271
1,390 (12)	66,792	253 (2)	9,364	9 (1)	838	1 (1)	181	62 (21)	4,742	99 (2)	4,000	—	—	47 (42)	7,714	112	32,873	4,659 (192)	353,204
1,116 (14)	56,431	386 (8)	27,262	17 (18)	2,618	36 (7)	2,955	591 (58)	25,486	—	—	57 (4)	7,296	1,387 (47)	61,054	1,410	148,921	10,312 (250)	740,081
4,336 (44)	142,665	1,598 (21)	53,455	2,746 (11)	49,438	420 (44)	10,946	84 (1)	4,095	105 (6)	6,873	10 (1)	1,610	279 (20)	18,414	597	26,034	13,879 (253)	438,092
9,675 (114)	423,095	3,917 (56)	156,674	3,526 (58)	77,775	775 (93)	28,655	836 (114)	43,868	315 (16)	14,277	84 (6)	11,959	3,011 (239)	168,576	3,273	317,053	43,793 (1,242)	2,362,255

Figures in parentheses denote number of machines. * Not including machine tool cutting parts.

Machine Tool Share Market

Although a brighter tendency developed towards the finish, stock markets generally were dull and unsettled during the period under review, and quiet conditions prevailed in nearly all sections.

British Government stocks suffered some setbacks, and home corporation and dominion loans eased in sympathy, but final prices were well above the lowest.

The commercial and industrial sections were subdued, and for the most part share prices moved to lower levels, but the tone steadily strengthened following a mild revival of buying activity, and by the close some gains had been established.

Among machine tool issues, Brooke Tool advanced 1½d. to 7s. 7½d.; Coventry Gauge & Tool, 2s. 3d. to 31s. 7½d.; Noble & Lund, 3d. to 5s. 6d.; W. E. Sykes "B," 1½d. to 24s. 4½d. On the other hand, Edgar Allen lost 6d. at 31s. 6d.; Asquith Machine Tool, 6d. at 10s.; Birmingham Small Arms, 1s. 6d. at 19s.; British Oxygen, 1s. at 14s.; Broom & Wade, 2s. 6d. at 22s.; Chas. Churchill, 1½d. at 8s. 7½d.; Geo. Cohen, 6d. at 9s. 6d.; Craven Bros. (Manchester), 4½d. at 8s. 4½d.; John Holroyd "B," 6d. at 17s. 9d. Kerry's (Great Britain), 3d. at 8s. 3d.; Samuel Osborn, 3s. at 52s. 6d.; Sanderson Kayser, 6d. at 34s. 3d.; John Shaw & Sons (Wolverhampton), 1½d. at 14s. 4½d.; and Thos. W. Ward, 1s. 3d. at 65s.

ARNOTT & HARRISON, LTD.—Interim dividend 7½ per cent.

New Companies Registered*

ROLLS-COLSTON APPLIANCES, LTD., Alderman's House, Bishopsgate, London, E.C.2.—Registered November 17, 1961. To carry on the business of manufacturers of and dealers in dishwashers, etc. Nom. cap.: £250,000 in £1 shares. Directors: Sir Charles B. Colston, R. R. Harris, M. Colston, A. Wright, J. Bloom and H. Oppenheim.

SWITCHGEAR ENGINEERING, LTD.—Registered November 21, 1961. To acquire patents, patent rights and machinery; to carry on the business of engineers and manufacturers of mechanical and electrical apparatus and machinery, etc. Nom. cap.: £40,000 in £1 shares. Directors not named. Subscribers: A. H. Isaacs and E. H. Harden, Saddlers Hall, Gutter Lane, London, E.C.2.

* From the lists compiled by Jordan & Sons, Ltd., Company Registration Agents, 116-118 Chancery Lane, London, W.C.2.

COMPANY		Denom.	Middle Price
Abwood Machine Tools, Ltd.	Ord.	1/-	1/3
Allen (Edgar) & Co., Ltd.	Ord.	£1	31/6
" " "	5% Prf.	£1	13/3
Arnott & Harrison, Ltd.	Ord.	4/-	12/-xd
Asquith Machine Tool Corp., Ltd.	Ord.	5/-	10/-
" " "	6% Cum. Prf.	£1	16/6
Birmingham Small Arms Co., Ltd.	Ord.	10/-	19/-
" " "	5% Cum. "A" Prf.	£1	13/-
" " "	6% Cum. "B" Prf.	£1	16/6
" " "	4% 1st Mort. Deb.	Stk.	90½
British Oxygen Co., Ltd.	Ord.	5/-	14/-
" " "	6% Cum. Prf.	£1	18/6
Brooke Tool Manufacturing Co., Ltd.	Ord.	5/-	7/7½
Broom & Wade, Ltd.	Ord.	5/-	22/-
" " "	6% Cum. Prf.	£1	16/-
Brown (David) Corporation, Ltd.	5½% Cum. Prf.	£1	14/-
Buck & Hickman, Ltd.	6% Cum. Prf.	£1	17/-
Butler Machine Tool Co., Ltd.	Ord.	5/-	15/-
" " "	5% Cum. Prf.	£1	12/6
Churchill (Charles) & Co., Ltd.	Ord.	2/-	8/7½
" " "	6% Cum. Prf.	£1	25/7½‡
Clarkson (Engrs.), Ltd.	Ord.	1/-	6/10½
Cohen (George), 600 Group, Ltd.	Ord.	5/-	9/6
" " "	4½% Cum. Prf.	£1	12/-
Coventry Gauge & Tool Co., Ltd.	Ord.	10/-	31/7½
" " "	5% Cum. Red. Prf.	£1	16/3
Craven Bros. (Manchester), Ltd.	Ord.	5/-	8/4½
Elliott (B.) & Co., Ltd.	Ord.	1/-	2/9
" "	4½% Red. Cum. Prf.	£1	11/3xd
Firth Brown Tools, Ltd.	4% Cum. Prf.	£1	10/6
Greenwood & Batley, Ltd.	Ord.	10/-	16/10½
Harper (John) & Co., Ltd.	Ord.	5/-	8/3
" " "	4½% Red. Cum. Pref.	£1	9/6
Herbert (Alfred), Ltd.	Ord.	£1	64/-
Holroyd (John) & Co., Ltd.	"A" Ord.	5/-	20/-xd
" "	"B" Ord.	5/-	17/9xd
Jones (A. A.) & Shipman, Ltd.	Ord.	5/-	25/-
" "	7% Cum. Prf.	5/-	4/6xd
Kearney & Trecker-C.V.A., Ltd.	5½% Red. Cum. Prf.	£1	8/9
" " "	Prefd. Ord.	£1	13/9
Kearns (H. W.) & Co., Ltd.	Ord.	5/-	21/3xd
Kerry's (Gt. Britain), Ltd.	Ord.	5/-	8/3
Macreadys Metal Co., Ltd.	Ord.	5/-	15/-
Martin Bros. (Machinery), Ltd.	Ord.	2/-	2/6
Massey (B. & S.), Ltd.	Ord.	5/-	11/-
Newall Engineering Co., Ltd.	Ord.	2/-	7/-
Newman Industries, Ltd.	Ord.	2/-	7/-
" "	6% Prf. Ord.	5/-	5/-
Noble & Lund, Ltd.	Ord.	2/-	5/6
Norton, W. E. (Holdings), Ltd.	Ord.	2/-	9/6xd
Osborn (Samuel) & Co., Ltd.	Ord.	5/-	52/6
" " " "	5½% Cum. Prf.	£1	22/-
Pratt (F.) Engineering Corporation, Ltd.	Ord.	5/-	14/6
Sanderson Kayser, Ltd.	Ord.	10/-	34/3
" "	6½% Cum. Prf.	£1	16/3
Scottish Machine Tool Corporation, Ltd.	Ord.	4/-	7/9xd
Shardlow (Ambrose) & Co., Ltd.	Ord.	£1	55/-
Shaw (John) & Sons, Wolverhampton, Ltd.	Ord.	5/-	14/4½
Sheffield Twist Drill & Steel Co., Ltd.	Ord.	4/-	21/9xd
" " "	5% Cum. Prf.	£1	13/3
Stedall & Co., Ltd.	Ord.	5/-	7/6
Sykes (W. E.), Ltd.	"B" non-voting Ord.	10/-	24/4½
Tap & Die Corporation, Ltd.	Ord.	5/-	19/-
" " "	4½% Deb. 1961-1977	Stk.	81½xd
Wadkin, Ltd.	Ord.	10/-	26/-
Ward (Thos W.), Ltd.	Ord.	£1	65/-
" "	5% Cum. 1st Pref.	£1	13/6
" "	5% Cum. 2nd Pref.	£1	20/-
Willson Lathes, Ltd.	Ord.	1/-	2/6

The Middle Prices given in the list are in several cases nominal prices only and not actual dealing prices. Every effort is made to ensure accuracy, but no liability can be accepted for any error. * Sheffield price. ‡ Birmingham price.

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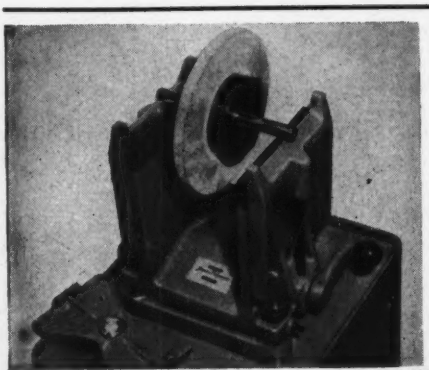

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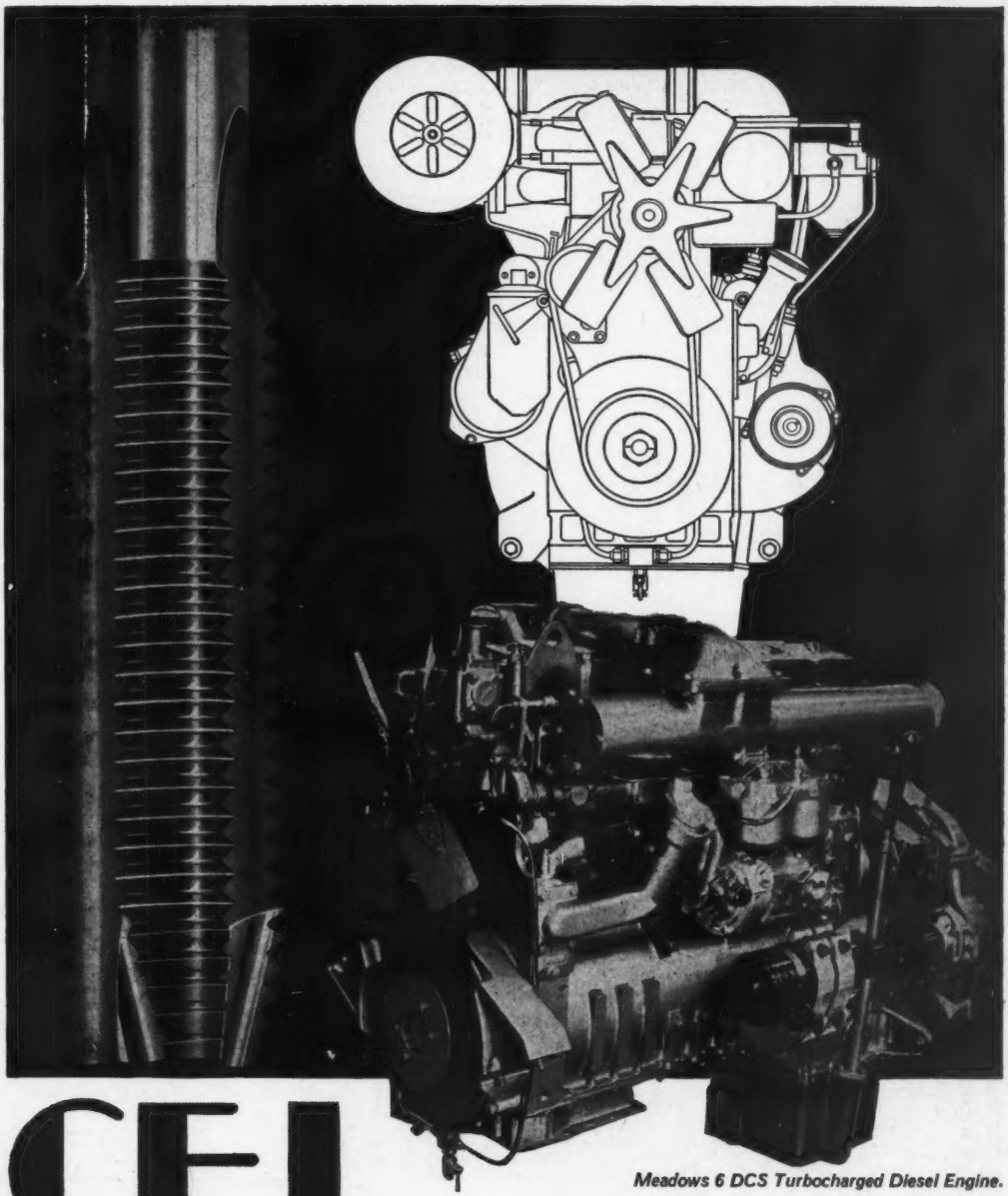

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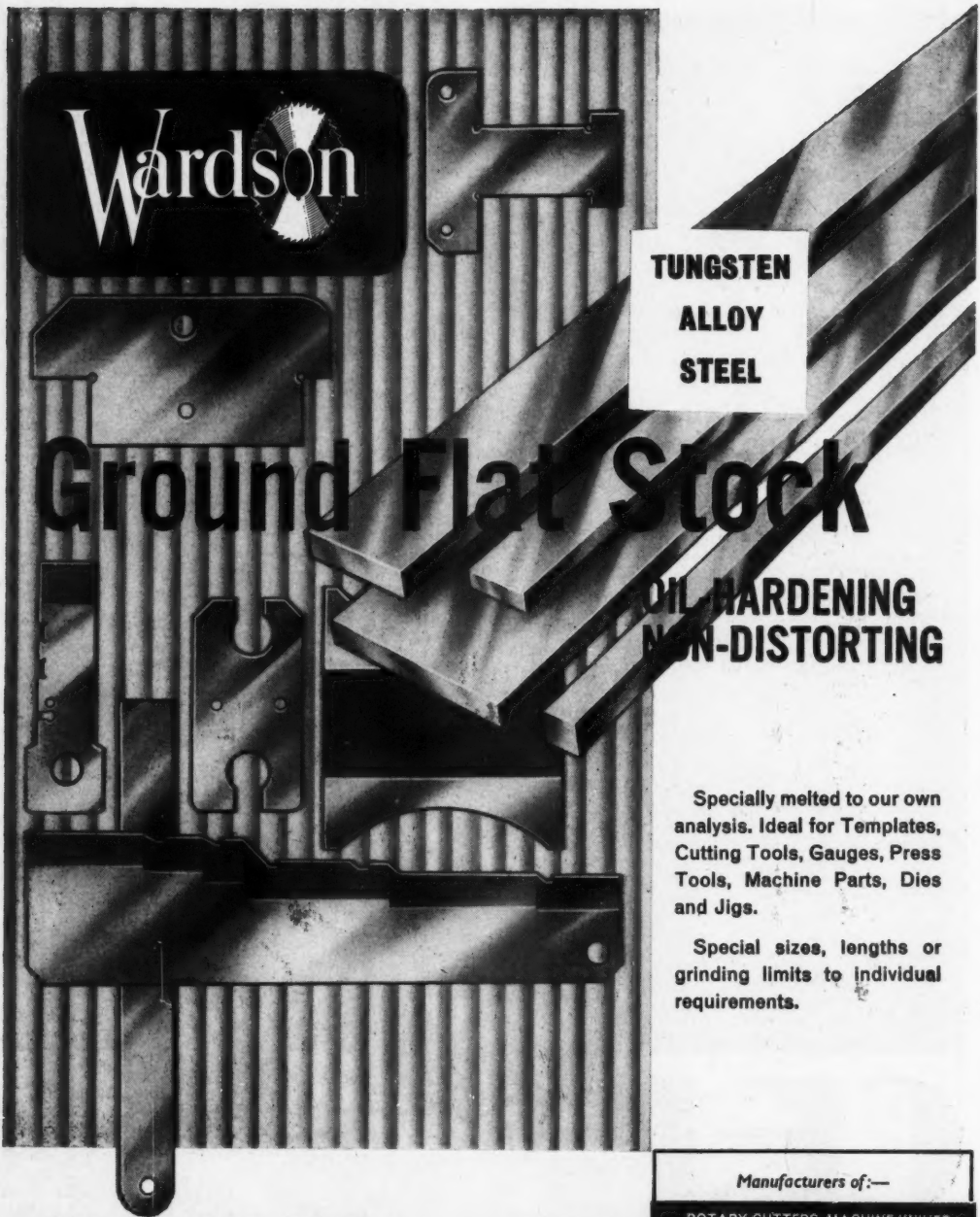

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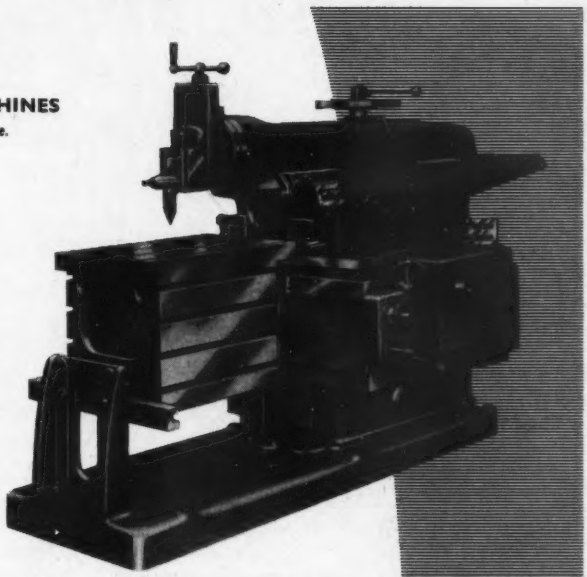

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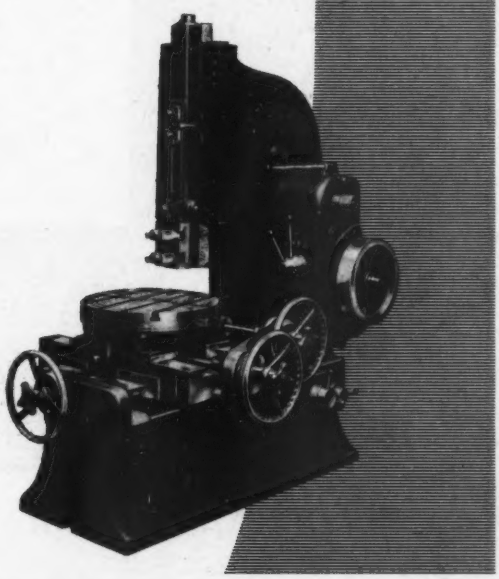

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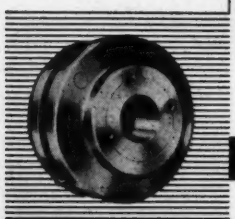

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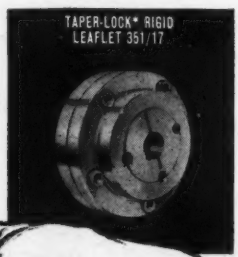

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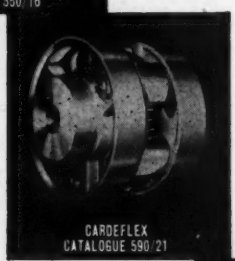

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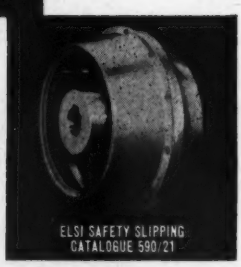

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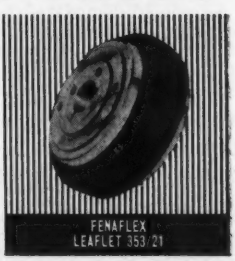

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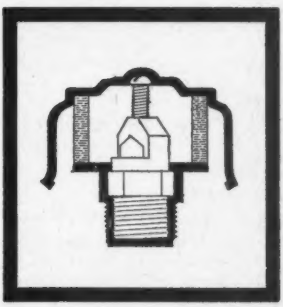

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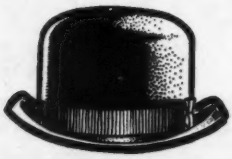

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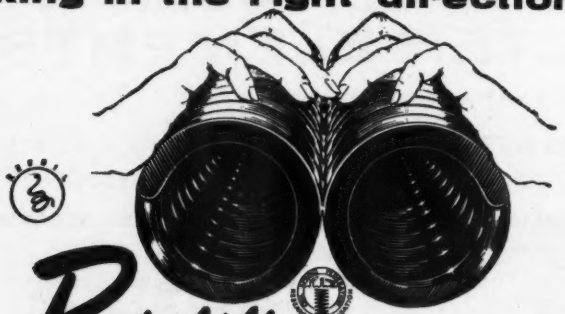

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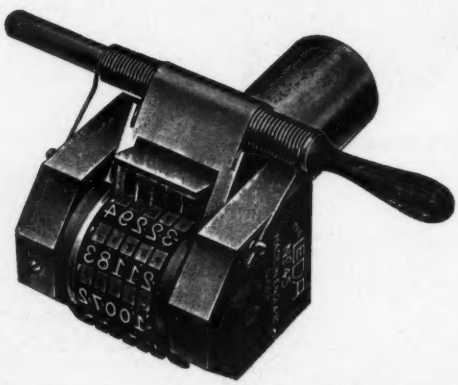

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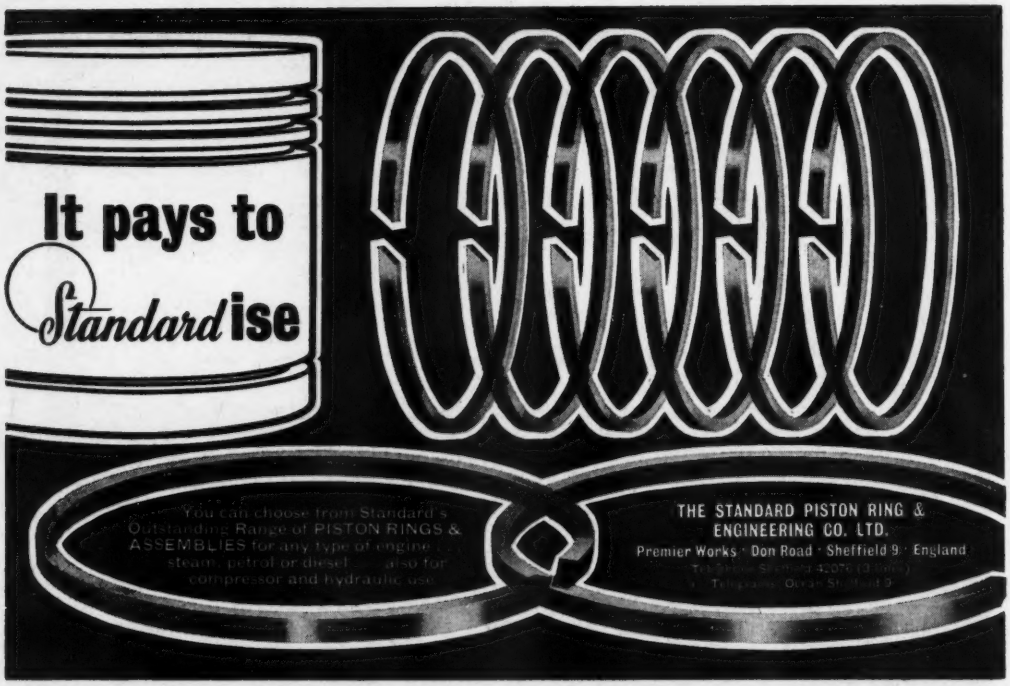
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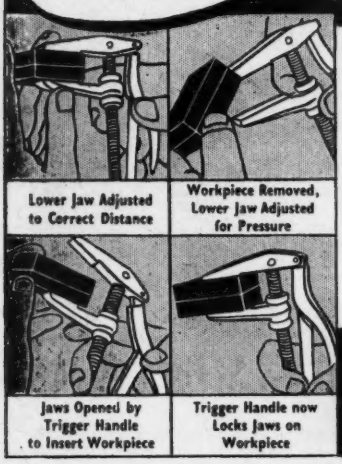
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Workpiece Removed, Lower Jaw Adjusted for Pressure
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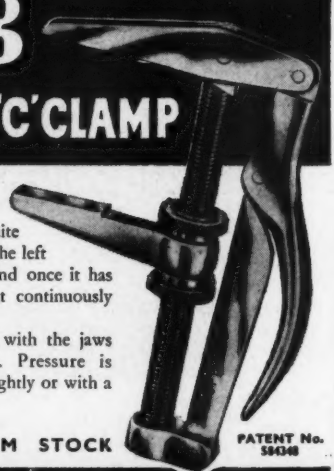

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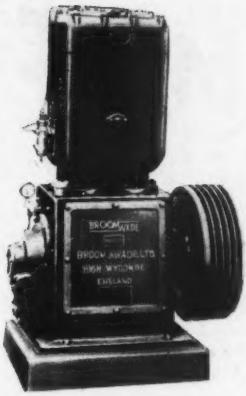

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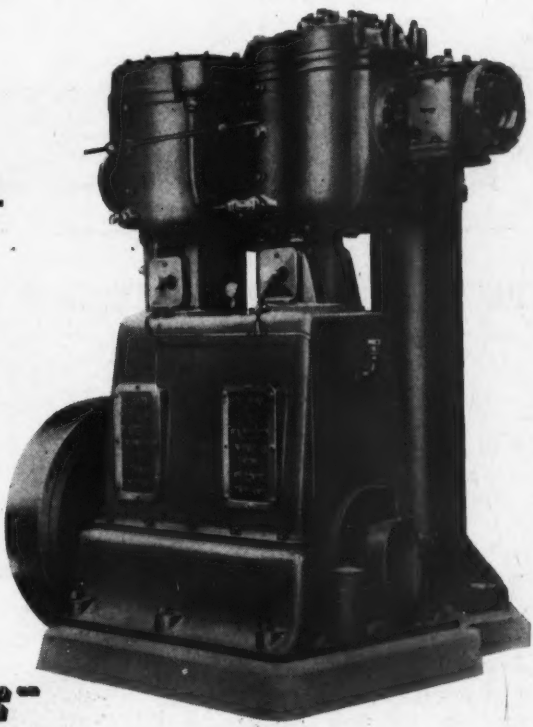

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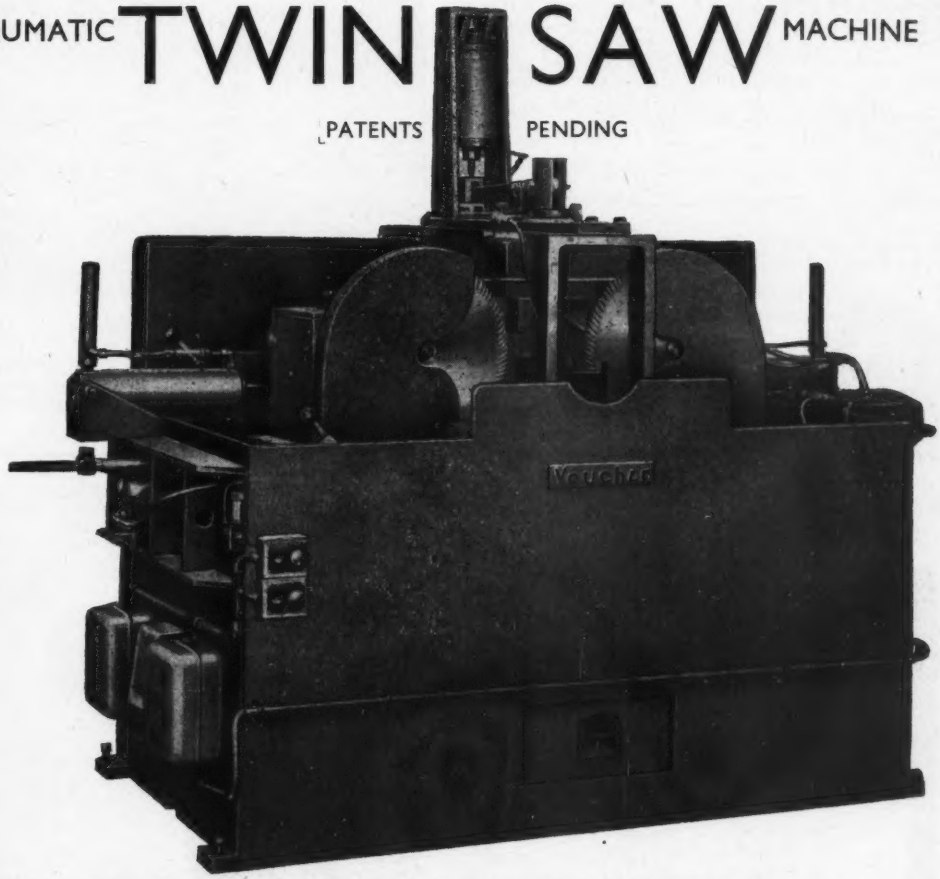

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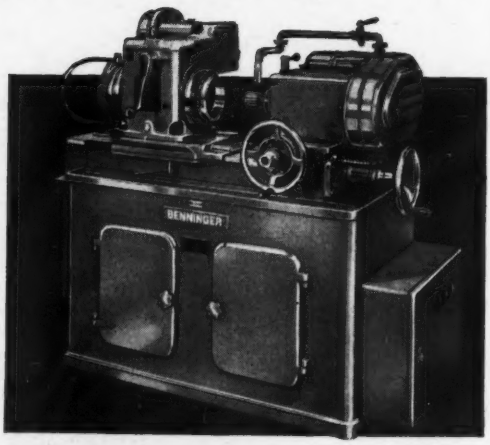

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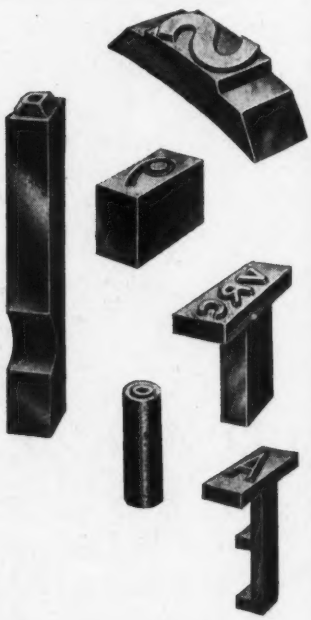

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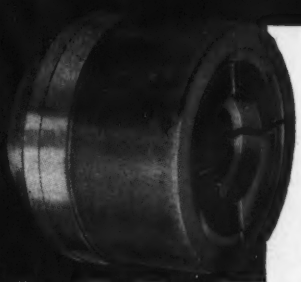

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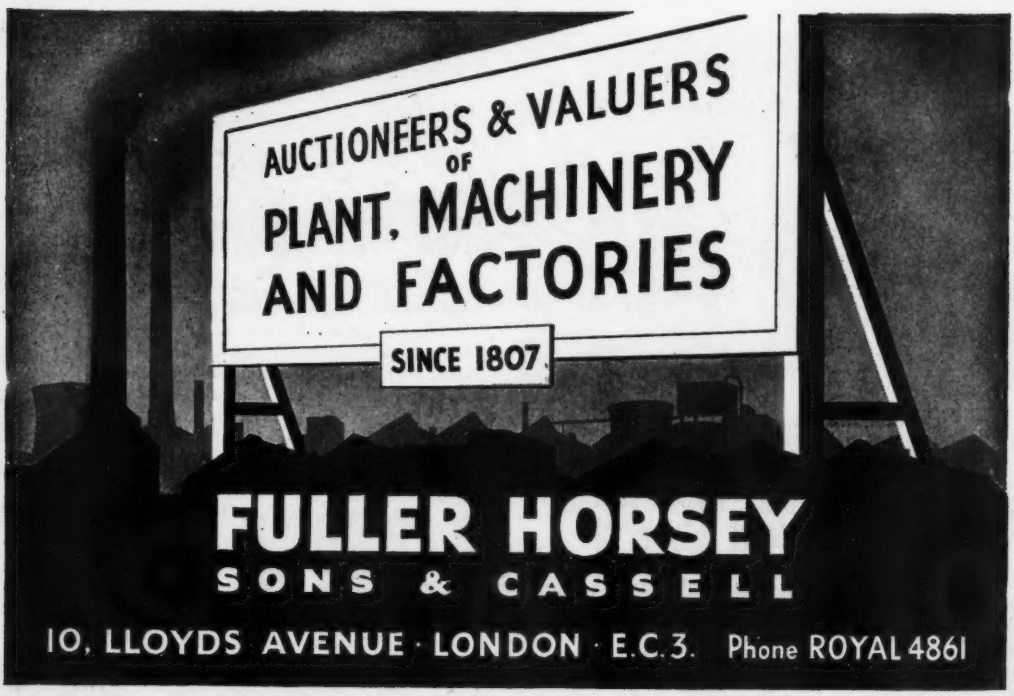

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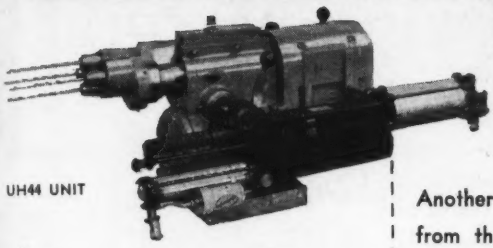

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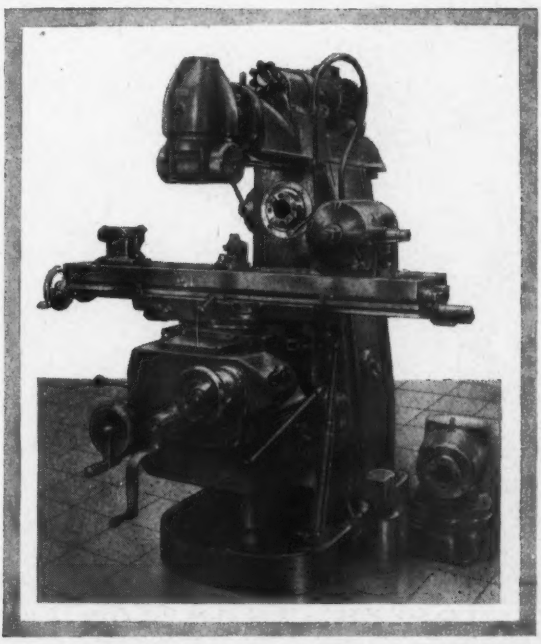

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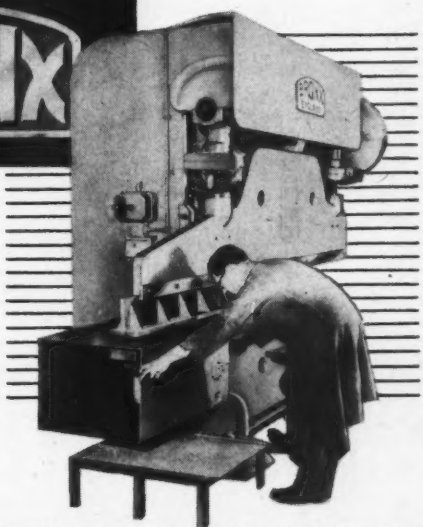

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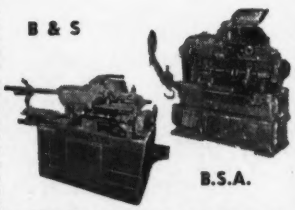

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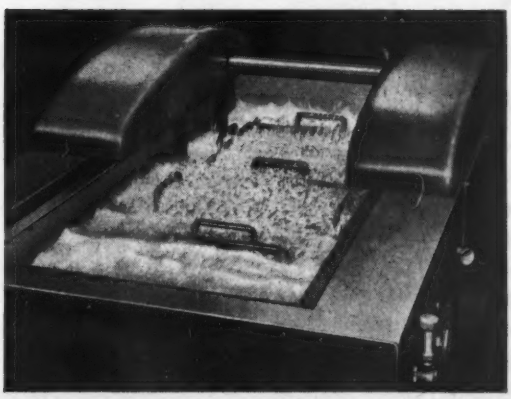

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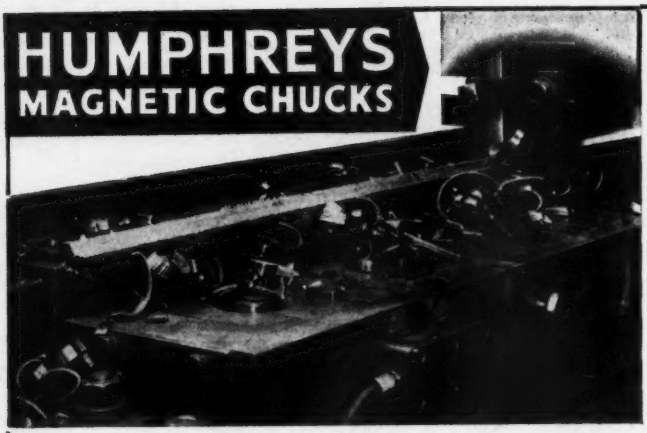

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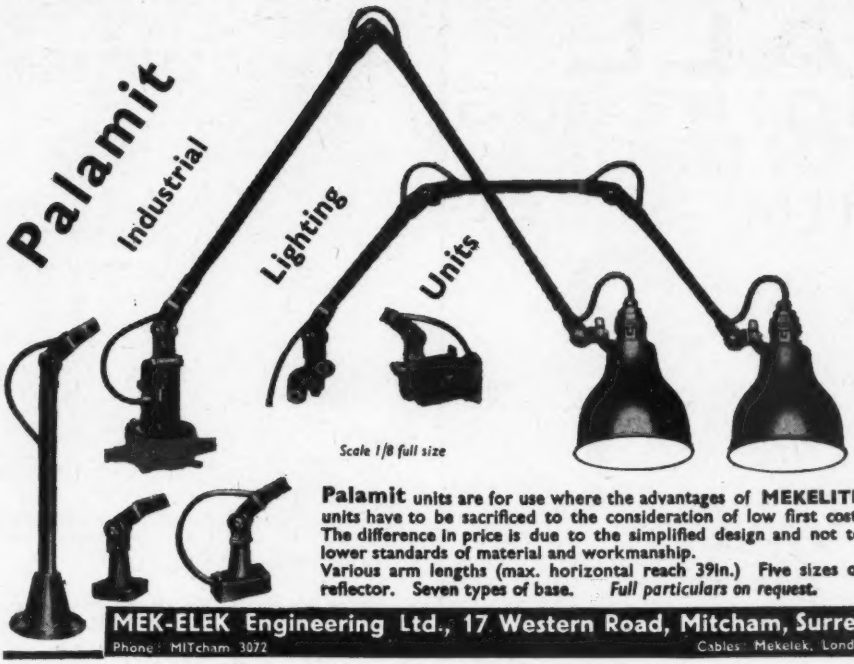

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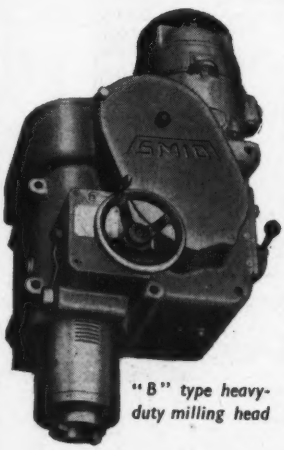

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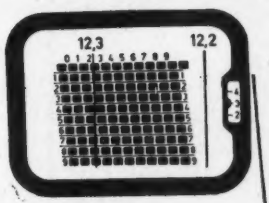

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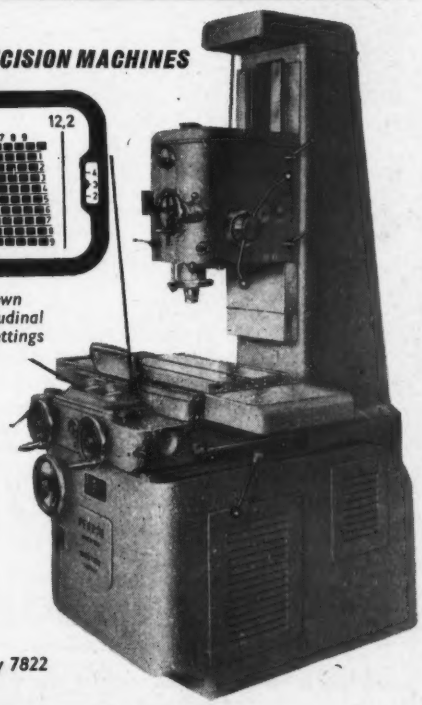

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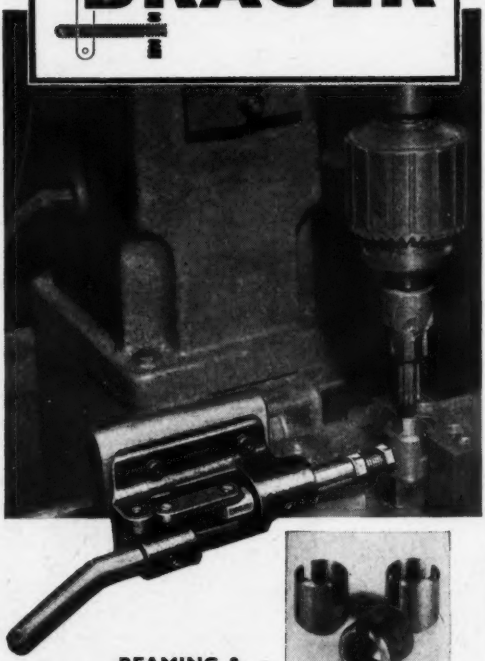

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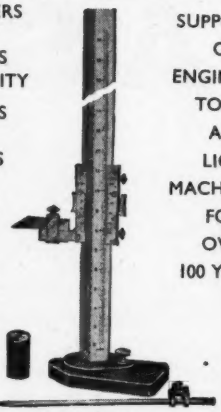

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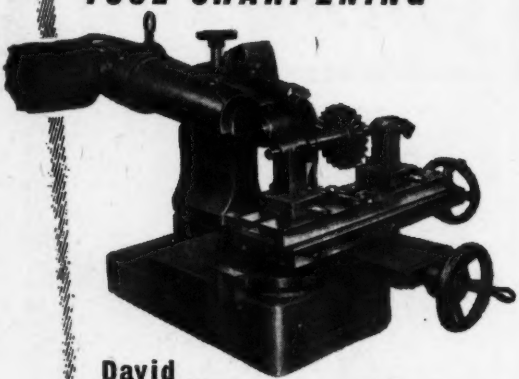

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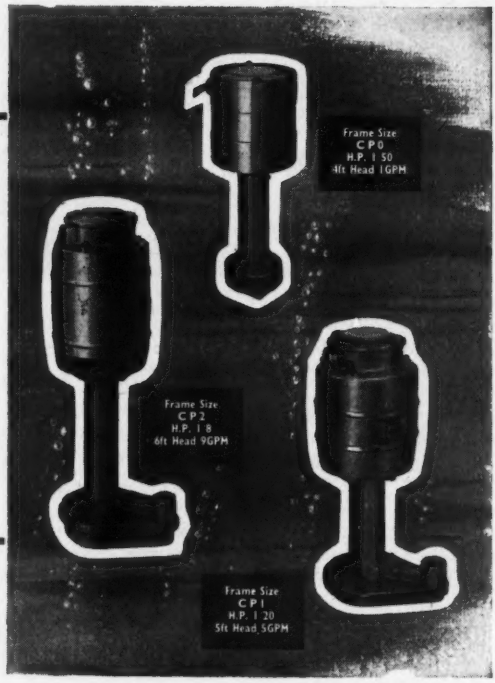

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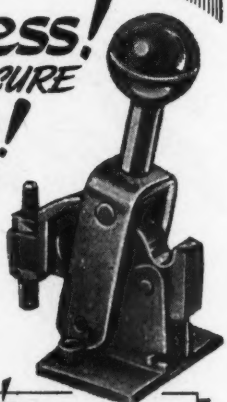

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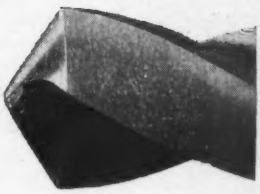

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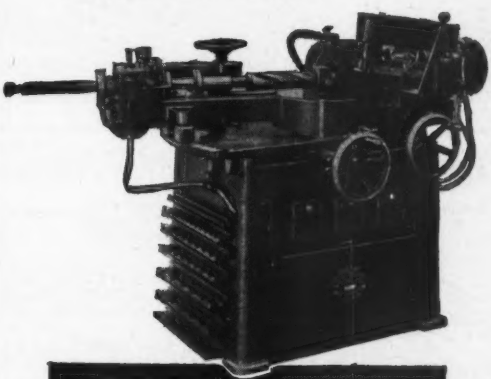

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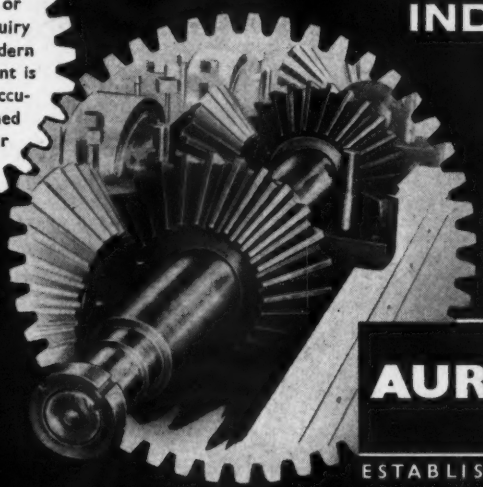

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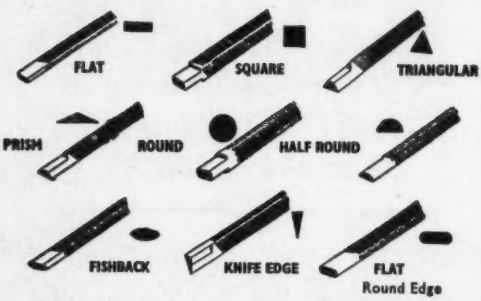

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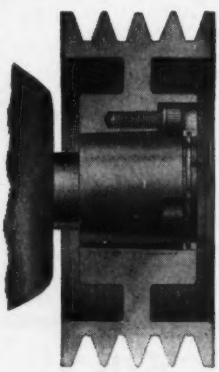

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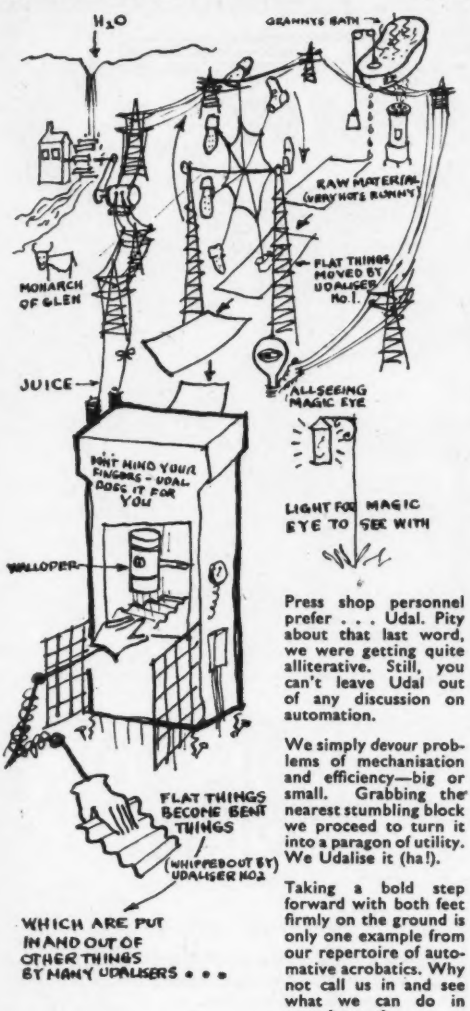
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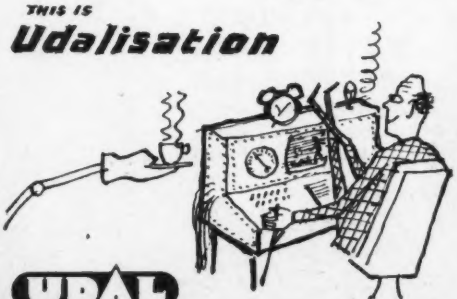

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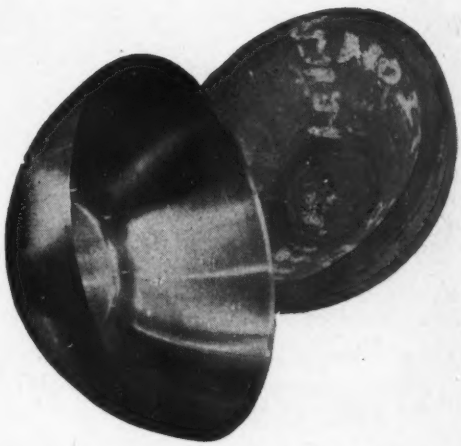

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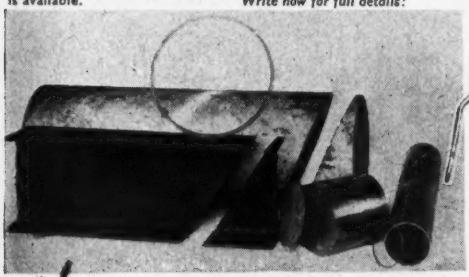

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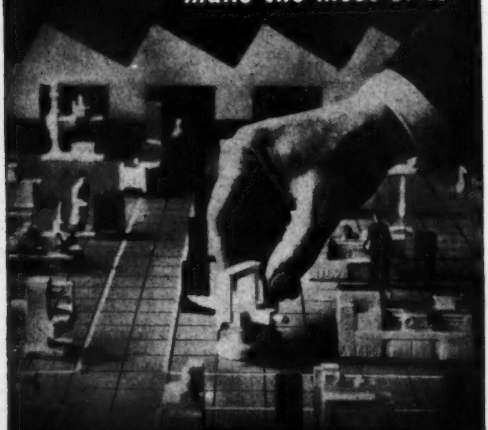

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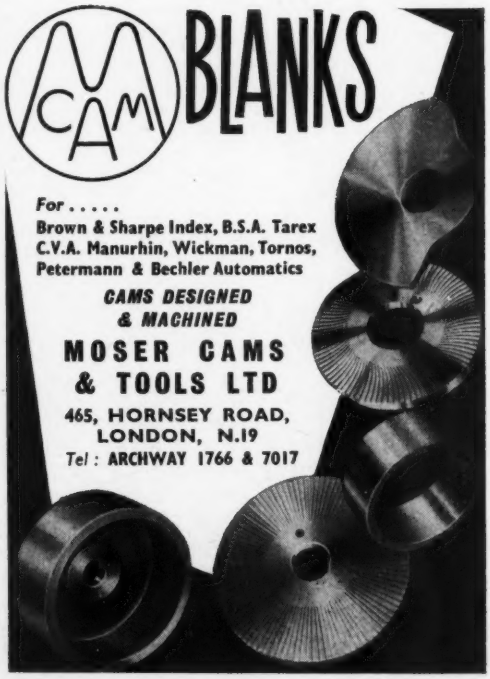

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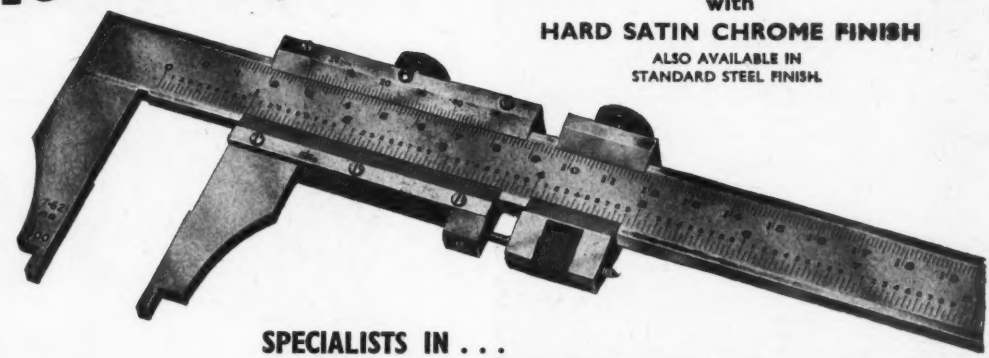

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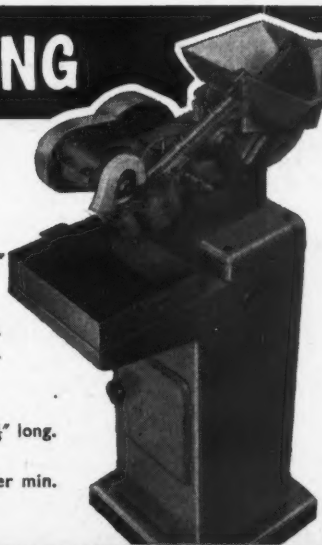

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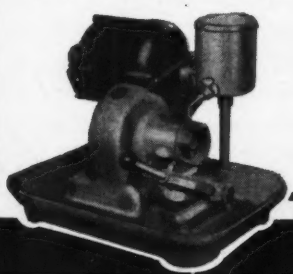

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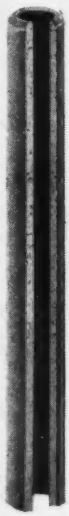

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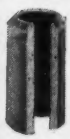

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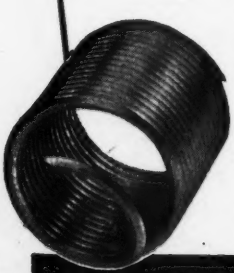

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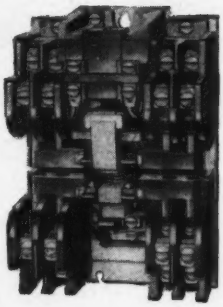

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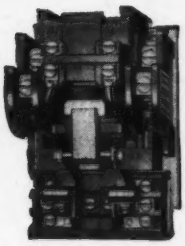

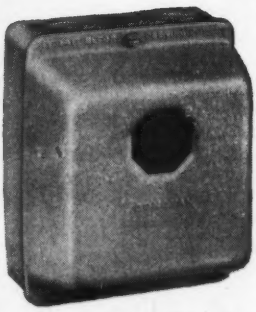

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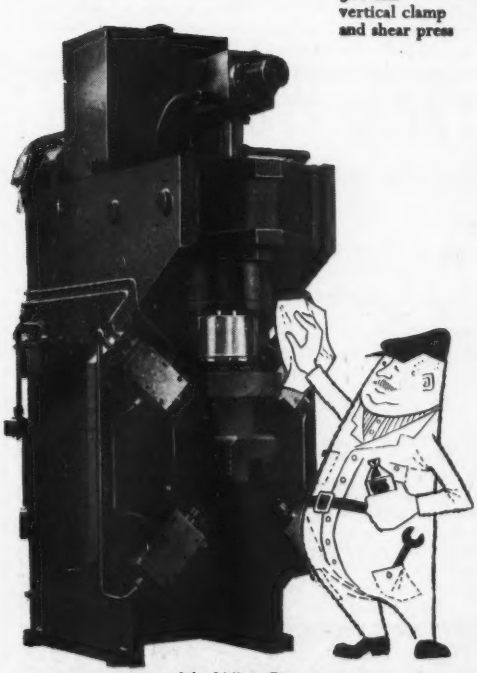

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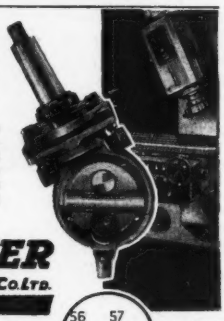

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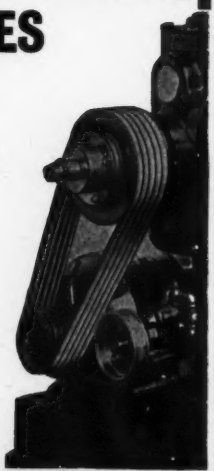

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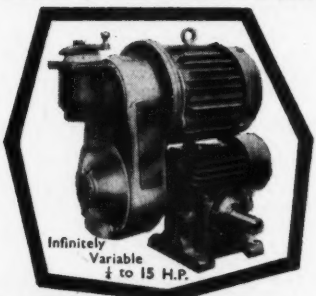

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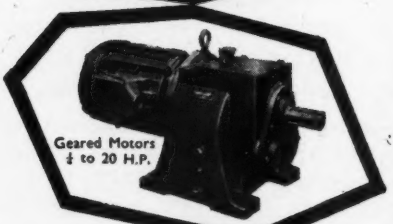

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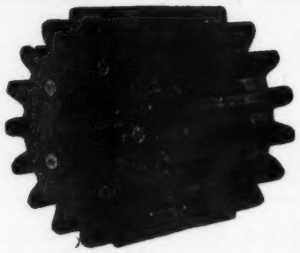

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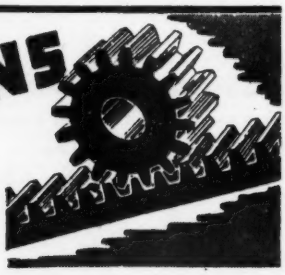

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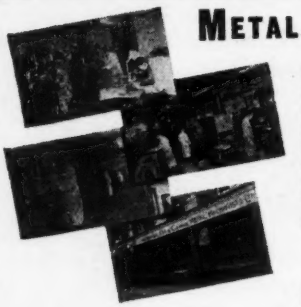

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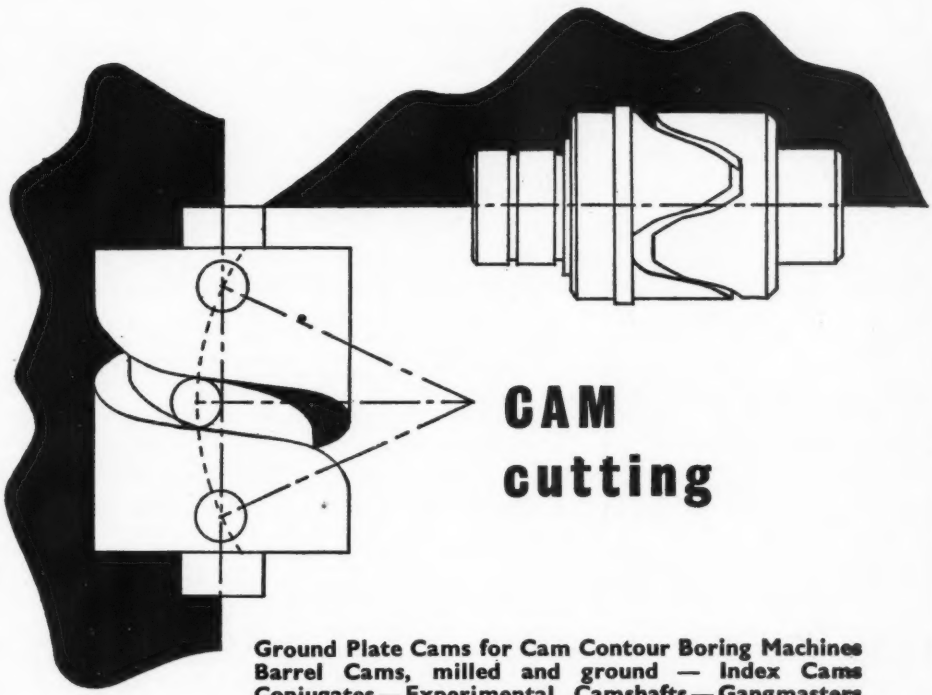

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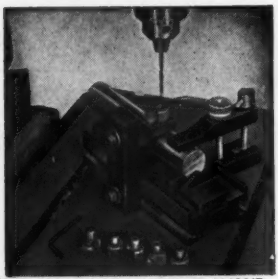

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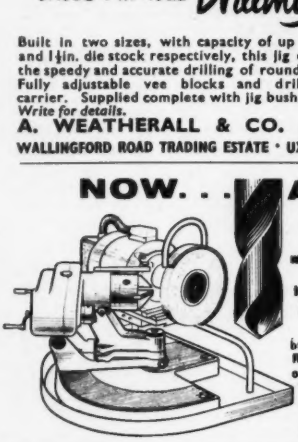

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Elliott Machine Tool Exhibition at Willesden—11 - 15th December.
B. ELLIOTT (MACHINERY) **LTD**
VICTORIA WORKS, LONDON, N.W.10
Tel. ELGAR 4050

K·E·N·T

CAPSTANS
Ward 2C. late machine First class.
Ward 3A, good condition, late machine.
Murad 1in. power feed. 1960 machine.
Boley & Leinen SR26 1⅛in. capacity.

LATHES
Colchester Triumph 7½in., as new.
Betts Bridgeford 14in. × 16ft.
Le Blond "Regal" S.S. & S.C. 6½in. × 24in.
Graham & Normanton surfacing and boring. 44in. swing in gap.
Le Blond "Regal" S.S. & S.C. 8in. × 36in.
Lang S.S. & S.C. gap bed. 12½in. × 14ft. swings 45in. in gap.

MILLING MACHINES
Glewont model 4 F.W.A. universal. Very well equipped, as new.
Herbert No. 1 horiz. 16in. × 5in. table.
Herbert No. 10 vert. 25in. × 6½in. table.
Asquith 2 spindle profile mill.
Archdale 14in. horiz. 29in. × 8½in. table.
Rigid 12½in. horiz. built-in telesc. brace.
Archdale 20in. horiz. Very good condition.

PRESSES
Weingarten 30 ton, open fronted, inclinable.
Raskin R5A 60 ton, only one still available.
Raskin R4 50 ton, UDAL guards, only 3 left.
Edwards B.A.19, 18 ton, adjust. stroke, Inc.

GRINDERS
Abwood tool & die Vert. spindle Surface grinder, 18in. × 6in. by 10½in. (under wheel). NEW condition.
Rowland 14in. heavy duty, wet & dry grinding.
B.S.A. centreless No. 7 5/8 in.-3in. capacity.
Brown & Sharpe No. 2 18in. × 6in. surface grinder.

AUTOS
Brown & Sharpe O.G. Single Spindle ½in. cap.
Index OR 12 Single spindle bar feed, tooling.
C.V.A. No. 8 single spindle ½in. capacity. Very good.

DRILLS
Pollard 12AX 5 spindle. JACOBS chucks & guards.
Pollard 12AX 2 spindle bench drill, JACOBS chucks etc.
Herbert single spindle sensitive pillar drill.
Jones & Shipman 2 spindle vertical flanged motor.
Storey 25 pillar. Good machine.

VARIOUS
Sigma Type Jig Borer and precision Milling and Drilling machine.
Invicta 18in. Shaper. Model 4M.

All motorised 400/3/50

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Classified Advertisements (*PLANT FOR SALE, contd.*)

Cashmores

Selection of Machine Tools from Stock

CENTRE LATHES

CARDIFF 8½in. S.S. & S.C. Gap Bed Lathe to admit 80in. between centres, approx. 2 years old (2 machines available).
SWIFT 12½in. S.S. & S.C. Gap Bed Lathe to admit 9ft. 0in. between centres.
MITCHELL of HALIFAX 7in. S.S. & S.C. Gap Bed Lathe to admit 3ft. 0in. between centres.
GRANOR 12½in. S.S. & S.C. Gap Bed Lathe to admit 12ft. 9in. between centres.
MITCHELL of KEIGHLEY 8½in. S.S. & S.C. Lathe to admit 4ft. 3in. between centres.
MITCHELL of KEIGHLEY 10½in. S.S. & S.C. Lathe to admit 4ft. 0in. between centres.
VOLMAN 8in. S.S. & S.C. Gap Bed Lathe to admit 4ft. 6in. between centres.

DRILLING MACHINES

New **PROGRESS** 4E and 5E Pillar Drilling Machines.
ARCHDALE 5ft. Elevating Arm Radial Drilling Machine, No. 5 M.T. spindle.
New **RICHMOND** Model SR2 3ft. 0in. Radial Drilling Machine. Fixed arm No. 3 M.T. spindle.
SWIFT 4ft. 6in. Model A1 Elevating Arm Radial Drilling Machine, No. 4 M.T. spindle, motorised 400-440/3/50 cycles.

GRINDING MACHINES

BROWN & SHARPE No. 5 Horizontal Spindle Surface Grinding Machine, 24in × 8in. capacity, hydraulic feed to table.
JONES & SHIPMAN Vertical Spindle Surface Grinding Machine, 18in. × 6in., hydraulic feed to table.
NORTON 6in. × 30in. Hydraulic Plain Cylindrical Grinding Machine, maximum wheel diameter 20in.

MILLING MACHINES

New **DENBIGH** D4 Horizontal Miller, 46in. × 10in. table.
HYPERMILL 7/27 Production Type Milling Machine, 43in. × 10in. table.
MIDGLEY & SUTCLIFFE Hand Lever Feed Milling Machine, 16in. × 5in. table.
EDGWICK No. 2 Dial Type Plain Horizontal Milling Machine, 46in. × 11in. table.
ARCHDALE 20in. Dial Type Horizontal Milling Machine, 40in. × 12in. table.
GREENWOOD & BATLEY Plain Horizontal Milling Machine, working surface of table 20in. × 10in.
EDGWICK 18in. Horizontal Plain Production Milling Machine, with 40in. × 12in. table.

POWER HAMMERS

ALLDAYS & ONIONS 2 cwt. Clear Space Type Pneumatic Power Hammer.
MASSEY 5 cwt. Pneumatic Side Type Power Hammer.

SAWING MACHINES

New **WICKSTEED** 10in. capacity Power Hacksaw.
New **STARTRITE-SABRE** Vertical Metal Cutting Bandsaw, 20in. throat.

SHEET METAL WORKING MACHINERY

RUSHWORTH 10ft. × ¼in. Pyramid Type Bending Rolls.

SLOTTING MACHINES

BUTLER 14in. stroke All Geared Slotting Machine with 39in. diameter rotary table.
DUTRANNOIT 24in. stroke Precision Slotting Machine, with swivelling head, 39½in. table.

SHAPING MACHINES

New **ALBA** 18in. and 24in. Shaping Machine.
New **INVICTA** 24in. and 18in. stroke Shaping Machines.

SHEARING MACHINE

New **KEETONA** 8ft. 0in. × ¼in. Undercrank Guillotine Shearing Machine.

STRAIGHTENING ROLLS

BRONX 8ft. 0in. × ¼in. Straightening Rolls, 5 roll type.

All the above machines are motorised 400-440/3/50 cycles

JOHN CASHMORE LTD
NEWPORT 1, MON.
Tel.: Newport 66941 (6 lines)

B.S.A. 9in. Auto Chuckers.
VICTORIA V2 Vertical Miller, 1957.
GREENLEE 1in. 6-sp. Auto.
LANG 10 × 54in. Gap Lathe.
RYDER No. 6 Vertical Autos.
HEALD 46B, 49 Boremastics.
GORTON 9J Copy Miller, 1942.
NEW BRITAIN GRIDLEY 61 1¼in. and 2¼in. Six Spindle Autos. Late.
WICKMAN 1¼in. 5-Spindle Auto.
EDGWICK Type A 1611 Diecaster.
SIDNEY 36in. swing × 120 Lathe.
REED PRENTICE 1½ G Diecaster.
GRIDLEY Type L 5in. and 2½in. 8.Sp. Autos.
ELECTRAULIC VBH, 15 ton Broach.
VICTORIA U3 Monotrol Miller, 1953.
CONOMATIC 8 sp. 1¼in. Bar Auto.
BROWN & WARD ¾in. and 1¼in. Autos.
WARD 2A and 3A Capstans.
CLEVELAND 1¼in., 2in., 2½in. Autos.
Three **UNION** ¾in. Pedestal Drills. NEW.
BULLARD 16in., 6-sp. Mult-au-Matic, 1943.
GLEASON 12in. Bevel Gear Generator.
FELLOWS 61A, 645A Gear Shapers.
BRYANT 16-38 Internal Grinder.
HEENAN-FROUDE Baling Press, 1947.
SCHULER Vertical Dieing Press.
HERBERT 9S Turret Lathe.
MILWAUKEE 2H Vertical and Plain Mills.
BLISS 304A 50 ton Press, 4in. stroke.
NORTON 14 × 72 Univ. Grinder.
DEFIANCE 25A Horizontal Borer.
NEWALL type L 10in. × 48in. Grinder, 1942
HEALD 72A Internal Grinders (2).
NORTON 12 × 36 Universal Grinder.
WARNER & SWASEY 5 and 2A Turrets.
PRATT-WHITNEY 12B 2-sp. Profiler. 1941.
EDGWICK No. 2 Universal Miller.
CHURCHILL No. 1 Planetary Grinder.
ORCUTT HM24 Gear Grinder, 1944.
GISHOLT 1L, 2L Turret Lathes, 1941-43.
ARCHDALE 18in. and 30in. Vert. Mill, 1942.
MONARCH Copying Pathe, 1946.
BROWN & SHARPE No. 20 Pl. Grinder.
HERBERT Auto Juniors.
STANLEY 8½in. × 60in. gap. lathe.
EXCELLO 1212 Double end fine borer

All modern fully motorised machines.

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AND AT WOLVERHAMPTON

Besco No. 14 Heavy Double Sided Fly Press for sale. Suitable for tool testing. Dia. of screw 3½in. Max. stroke 8in. Bed 32in. × 30½in. Hole in bed 23½in. × 17½in. Max. daylight bed to ram 30½in.—F. J. EDWARDS LIMITED, 359, Euston Road, London, N.W.1, or 41, Water Street, Birmingham 3.

Newall 10-U Precision Lapping Machine, 14in. rotary table, current model. 440/3/50. £235.—BOX D421, MACHINERY, Clifton House, Euston Road, N.W.1.

SWIFT 10in. H/T of centres, 12ft. B/T centres. Neatly converted mot. thro. gear box. 30in. 4 jaw & 16in. 3 jaw chucks. Space required, must sell. Price £150. Offers accepted.

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NORTON 10in. × 48in. Plain External Grinding Machine. Hydraulic feeds.

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(Machine Tools) Ltd.

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LATHES

SOUTHBEND 9in. Model C, S.S. & S.C. Bench.
LE BLOND 13in. Regal S.S. & S.C., taper turning.
SOUTHBEND 14½in. × 36in. S.S. & S.C. taper turning.
LANG Junior 17in. × 60in. S.S. & S.C.
LE BLOND 15 RP S. & S., 15in. × 24in.
LANG 36in. Surfacing and Boring.
RYDERMATIC No. 12 Multi-Tool.
D.S.G. 13Z Minor, S.S. & S.C.
WILLSON 6½in. × 36in. Gap Bed S.S. & S.C

CAPSTANS AND AUTOS

ACME 5W Capstan, chuck machine.
HERBERT 2S, Flamard Bed.
WARD No. 7 Capstan, chucker.
HERBERT 4B D/L chuck and bar feed.
TAYLOR No. 1263 Capstan, ¼in. cap.
BROWN & SHARPE No. 2WF 1in.
MURAD 3Q.

DRILLS

KITCHEN & WADE 7ft. Radial, 5 M.T.
HERBERT "V," "V" Junior and "C" Pillar.
FOSDICK 4BM 3-spindle H/sp.
CORONA 3M Pillar, 1½in. cap.

GRINDERS

LANDIS 25in. × 48in. Type "C" Hyd plunge feed.
CHURCHILL HBA Auto Internal.
MILFORD 6in. D/E Carbide Tool.
CHURCHILL BY, 10in. × 20in. "live" and "dead" workhead.
KEIGHLEY KN Internal.
BROWN & SHARPE No. 5 Surface.
BROWN & SHARPE No. 23 Plain, cap. 10in. × 48in.
BROWN & SHARPE No. 2 Surface, cap. 6in. × 18in.
SMART & BROWN Internal, 1½in. cap.
BROWN & SHARPE No. 5, 3in. × 18in. Plain.
BALLINGER 10/24 "Versatile" Abrasive Cutting-Off Machine.
NEWALL Model L.U. 10in. × 36in. Hyd. Universal.
B.S.A. LANDIS Type C 6in. × 18in. Hyd. Plain.
CHURCHILL Mod. H.C.B. Internal Auto Size.
HAHN & KOLB Hyd. Disc Lapping M/c.
NORTON 14in. × 36in. Hyd. Univ.

MILLERS—Vertical

C.V.A. 79 swivel head.
REED PRENTICE 3VG.
CINCINNATI Model O8 Production.
KENDALL & GENT Duplex Profile, table 15in. × 15in.

MILLERS—Horizontal

MILWAUKEE 1848 Simplex Bed Type Production.
CINCINNATI No. 2MH Plain High Speed.
CINCINNATI Mod. O8 Plain Automatic.
RICHMOND 2HS Plain, table 35in. × 9in.
ARCHDALE 20in., table 40in. × 10in.
CINCINNATI Mod. O.K. Prod., table 34in. × 12in.
ARCHDALE 14in. Plain, table 27in. × 8in

SAWING MACHINES

EHJ No. 13 Filing and Sawing.

SHAPERS

ALBA 4S.
AMMCO 6in., cabinet model.
TOWN 14in.

GEAR CUTTER

MAXICUT Gear Shaper, Model No. 2.

MISCELLANEOUS

T.T. & H. Javelin Etchers. Multi-heads (3 m/cs).
HEAP 2in. Screwing Machine.
BLISS No. 20 Inclinable.
BESCO 6ft. × ¼in. Undercrank Guillotine

Classified Advertisements (*PLANT FOR SALE, contd.*)

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AVAILABLE FROM STOCK

AUTOMATICS

FOOTBURT 1in.
B.S.A. ACME GRIDLEY ⅜in. 6 spindle. Rebuilt machine.
CONOMATIC 1¼in. 4 and 6 spindle. Rebuilt machines.
RYDERMATIC No. 12 Vertical Multi-Tool Lathe.

RADIAL DRILLS

KITCHEN & WADE 8ft. low base, with loose box table.

GRINDERS

BLANCHARD No. 16 Vertical Spindle, 26in. dia. magnetic table.
PALLAS No. 2 Surface, 18in. × 6in.
New ALPA Surface 32 × 8in.
JUNG AS Internal.
KEIGHLEY Type XL Hydraulic Plain Grinder, 6in. × 18in.
CHURCHILL 10in. × 24in. Universal.
LANDIS 12 × 48 Universal.
BROWN & SHARPE No. 3 Universal.

CAPSTAN AND TURRET LATHES

MURAD 3Q ⅜in. Capstan.
LIECHTI PR Turret Lathe (Swiss).
GISHOLT Turret Lathes. Type IL.
FOSTER No. 2B Turret Lathe.

CENTRE LATHES

HENDEY 6in. × 30in. Taper Turning.
MONDIALE 7in. × 60in. Gap Bed.

MILLERS

RICHMOND O1 Universal.
ADCOCK & SHIPLEY Model OA with "Multiform" Auto feed. Rebuilt.
WERNER No. 5160 Small Multipurpose. Vert. and Horiz. Table 22in. × 6¼in.
ARCHDALE 14in. Manufacturing type.
CINCINNATI Type OK, 18in. Horiz.
EDGWICK 18in. Horizontal.
ARCHDALE 20in. Twin Overarm Horizontal. Table 40in. × 10in.
KENT-OWENS 1-8 Hydraulic Production.
OLIVETTI FP2 Production—Unused.
CINCINNATI 3-24 Plain Hydromatic.
CINCINNATI 3-24 Duplex Hydromatic.
CINCINNATI 4-36 Duplex Hydromatic.
New TAYLOR Vertical, table 17¾in. × 5¼in.
ARCHDALE 12in. Vertical.
HERBERT No. 10 Vertical.
BROWN & SHARPE No. 2 Vertical Mill. Table 49¾in. × 14in.
MAS FV2A Vertical Mill. Table 52in. × 12in.
HERBERT 23V Vert. Table 68in. × 17in. 48in. traverse.
HELLER Automatic Thread Millers (4).
ASQUITH HKO Duplex Keyseater.

PRESS

V. & O. No. 11 Double Action. Approx. 10 tons. Roll feed. Max. draw 1in.

MISCELLANEOUS

NOBLE & LUND 11/16in. Fluifeed Cold Saw, fitted with pneumatic vice for tubes.
RICHMOND 4in. Light Duty Slotter.
New ALBA 18in. Shaper.

All machines motorised 400/3/50 unless otherwise stated.

ACBARS LIMITED,
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THE SPOT ● TO WATCH!

FOR GOOD CLASS SECONDHAND MACHINES AT LOW COST

C.V.A. No. 8 Automatics.
C.V.A. No. 12 Automatic.
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MODERN 1¼in. Automatic.
LAPOINTE Screw Broaching Machine 54in.
WARD 'OE' Capstans.
HERBERT No. 0 Capstan.
HERBERT 1S Capstan.
CORONA 4 Sp. Drill.
HERBERT 3 Spindle Drill.
PACERA 2 Spindle Drill.
CORONA 2 Spindle Drill.
SCRIVENER 1CA Centreless Grinder.
KAMENICEK Universal Grinder.
NEWALL Thread Grinder.
SOUTHBEND 14½in. Lathe.
LEBLOND Rapid Production Lathe.
HOGARTH Production Lathe.
SMALLPIECE 6 W.S.L. Multi Tool Lathe.

MILWAUKEE 4H Uni. Mill.
K. & T. 5HM Vertical Mill 1,300 r.p.m.
K. & T. 4H Horizontal Mill.
MANN 6ft. B.C. Threadmill.
MILWAUKEE 12in. × 18in. Simplex Mill.
SENTINEL 25T Power Press.
KELLER 1210 Diesinking Machine.
THIEL Punch Shaping Machine.
WICKSTEAD 6in. Hacksaw.

LATE AMERICAN MACHINES

FELLOWS 61A High Speed Gear Shaper.
GLEASON No. 16 Spiral Bevel Hypoid Gear Generator.
FELLOWS 612 High Speed Gear Shaper.
HEALD No. 22 Ring and Surface Grinder.
HEALD No. 49 Fine Hole Borer.

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Call for
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IMMEDIATE DELIVERY
NEW HARRISON 13in. Swing Straight Bed Lathe. 40in. between Centres. Motorised 400/3/50.
P. SIMPSON & CO. LTD.
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Milwaukee 21in. Shaper. Motorized £125; Band Flier, inclinable table, motorized, light, 7 file bands. £65. Double Action Roll Feed Press, 26 tons, motor, guards, etc. £95.—BOX D414, MACHINERY, Clifton House, Euston Road, N.W.1.

Excello 33 Thread Grinding machine, 1954 model, complete with equipment £1,625 ex works.—K. & C. MACHINERY LTD., Stephen Street. Coventry 23669.

HERBERT No. 9 Combination Turret Lathe. Speeds 14 to 400 r.p.m. 4¼in. hollow spindle.
PARKES (MACHINE TOOLS) LTD.,
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New 6ft. 0in. × 3ft. 6in.; 7ft. 0in. × 4ft. 0in.; and 10ft. 0in. × 3ft. 0in. Marking Off Tables for sale. Accurately machined top face and heavily ribbed. Mounted on cast iron legs. Total height approx. 34in.—Illustrations and full details from F. J. EDWARDS LTD., 359, Euston Road, London, N.W.1., or 41, Water Street, Birmingham, 3.

Fielding 50 ton Hydraulic Horizontal pipe bender, up to 6in. bore hydraulic tubes.
200 Ton Folding Downstroke Hydraulic Press, 14in. ram. 42in. stroke, 63in. daylight.
100 Ton Fielding ditto, 10in. ram, 72in. stroke, 99in. daylight.
Fielding 50 ton Hydraulic Horizontal Pipe Bender for 6in. thick tubes.
Bliss 90 Ton Geared Press. 10in. stroke.
3 Bliss No. 304 Vertical Single Action Drawing Presses. 7½in. stroke, 50 tons.
30 Ton open front Geared Inclinable Press.
Windsor 6-oz. Plastic Injection Moulder.
Sedgwick 6ft. × ¼in. Folder.
6ft. × ¼in. Overcrank Guillotine.
7ft. × 1in. Craig Donald Flattening Rolls.
"Pyramid" Bending Rolls, 9ft. 0in. × ¾in.
200 Ton Tangye Hydraulic Straightening Press, bed 25ft. × 3ft. stroke 21in., motorised travelling table, 2 ram pump.
Hugh Smith, Double Table Scarfing Machine, 13in. fixed stroke, from 16in. to 8ft. wide, 1¼in., thick steel plates.
Crow, Harvey Punch, Shears and Angle Cropper, 18in. blade, 27in. throat, heavy duty.
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Berry Plate Guillotine, capacity 4ft. × 1in.
New 1-cwt. and 2-cwt. Hammers by Massey and Alldays & Onions, also 3-5 cwt. secondhand E.O.T. Cranes.
30 Ton Marshall Fleming, 29ft. span, cab.
25 Ton Clyde, 21ft. 9in. span, cab control, 1954. Can convert any span to 95ft.
20 Ton King 42ft. 3in. span Unused.
15 Ton Heywood, 34ft. span, cab control.
10 Ton Heywood, 34ft. span. Unused.
10 Ton Morris, 32ft. 10in. span, cab control.
10 Ton, 60ft. span. 1955. (Two.)
5 Ton, 37ft. span. 1944.
3 Ton Morris, 149ft. span. 1954.

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Classified Advertisements (*PLANT FOR SALE, contd.*)

F. J. Edwards Ltd

GENERAL LATHES

STANLEY 7in. Gap Bed Lathe.
SOUTHBEND 7¼in. and 15in. Centre Lathes.
SMART & BROWN 4½in. Sabel Lathes.
LE BLOND REGAL 5in. Lathes.
LANG Junior 6½in. Lathe.
BETTS-BRIDGFORD 15in. centre × 22ft. bed Lathes, 16ft. between centres.
WILLSON 7½in. × 6ft. Gap Bed Lathe, admit 3ft. between centres, hollow spindle 2½in. dia
LE BLOND 20in. Rapid Production Lathe, admit 7ft. between centres.
LANG 26in. swing Surfacing and Boring and Screwcutting Lathe, hexagon turret, 3½in. hollow spindle.

MILLING MACHINES

PEDERSEN Horizontal Miller, table 49in. × 10in. capacity, 24in. × 7½in. × 16in.
ADCOCK & SHIPLEY 1AD Horizontal Miller; table 19in. × 7in.; capacity 10in. × 6in. × 10in.; 50-2,500 r.p.m.
EDGWICK No. 2 Dial Type Horizontal Miller, table 46in. × 11in., capacity 25in. × 7in. × 17in.
COCHRANE-BLY No. 14 Duplex Universal Vertical Milling and Shaping Machine, table 29in. × 9in., main head swivel 360 deg., shaper ram stroke 0in-6in.
KENT-OWENS No. 1-14 Production Miller, table 32in. × 9in., hydraulic feed and rapid traverse.
KENT-OWENS No. 1-8 Production Miller, table 25in. × 9in. U.S. Model MM5 Multi-Production Miller, table 21½in. × 6in.
HERBERT No. 46V Vertical Milling Machine, table 58in. × 15in., auto longitudinal feed 36in.
NEW Vertical Millers, with swivel head, table 33½in. × 10in., speeds 90 to 1,500 r.p.m.
CINCINNATI 08 High Speed Vertical Miller with power feed and rapid traverse, table 20in. × 6in., speed 150-1,300 r.p.m.
REED PRENTICE No. 3VG High Speed Vertical Millers; 36in. × 10in. table; capacity 24in. × 12in. × 18in.
REED PRENTICE No. 2 Vertical Miller, 20in. × 8½in. table, capacity 16in. × 11in. × 15in.; 3,330 r.p.m.
BROWN & SHARPE No. 2 Vertical Miller, swivel head, table 45in. × 10in., capacity 28in × 10in. × 15in.
CURD NUBE 2-spindle Vertical Profile Miller, table 17½in. × 14½in.
PROGRESS Universal Milling Machine, table 40in. × 10in.; capacity 24in. × 9in. × 18in.
VICTORIA U1 Universal Miller, table 40in. × 11in.; capacity 25in. × 8in. × 16in., speeds 31 to 1,010.
VICTORIA U2 Universal Milling Machine, table 45in. × 11in., with vertical milling attachment, slotting attachment and rotary table.
MILWAUKEE 2K Universal Miller, table 56in. × 12in., capacity 28in. × 10in. × 17in., 1,500 r.p.m.
BROWN & SHARPE 2A Universal Miller, table 45in. × 10in., capacity 28in. × 10in. × 18in.

PLANING MACHINES

BUTLER 36in. Openside Crank Planers, with side head, table 48in. × 23in.; admit 24in under cross slide; 4 to 40 strokes per minute.

SAWING MACHINES

RUSSELL 14in. Blade Hydraulic Circular Sawing Machine.
NEW **KALTENBACH** Model HDM750 Hydraulic Circular Sawing Machine, 30in. diameter blade to cut 9in. dia. bar, 16in. × 6in. R.S.J. SOLE BRITISH AGENTS.
NEW **KALTENBACH** 14in. Blade Model KKS 350 Universal Circular Sawing Machine to cut steel and non-ferrous metals any angle from 0 deg. to 180 deg. Send for particulars of this unusually versatile machine. Demonstrations gladly arranged. SOLE BRITISH AGENTS.
TAYLOR No. 1142 high speed Circular Saw for ¾in. bars, 1½in. tubes.

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Telephone: EUSTON 5000 Telex: 24264
And at Lansdowne House, 41, Water St., Birmingham, 3. *elephone: Central 7606-8*

NEWALL USED MACHINE DIVISION

HAVE AVAILABLE FOR EARLY DELIVERY

NEWALL / KEIGHLEY ' L ' 12 by 24 External Grinder, complete with built in Wheel Dressing Compensating Valve.

MILWAUKEE Vertical Milling Machine, Model 'H' 5ft. 3in. by 1ft. 3in.

HEALD 72A Internal Grinder.

NEWALL 836 Thread Grinder.

NEWALL 10-U Lapping Machine.

No. 16 BLANCHARD Surface Grinder.

All ex used stock

THE
NEWALL
USED MACHINE DIVISION
OUNDLE ROAD
ORTON LONGUEVILLE
PETERBOROUGH

Telephone: Peterborough 67116/7

B.S.A. 6in. × 20in. and 6in. × 12in. Multi-tool Lathes. Front and rear slides.

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Tel.: EASt 1742

CHURCHILL No. 2 CENTRELESS GRINDER
5in. capacity. Arranged for through-feed and plunge-feed grinding. Rebuilt and guaranteed. Price £1,750. Inspection by appointment.
MUNCASTER MACHINE TOOLS LIMITED, MARY STREET, MANCHESTER, 3
Phone: DEAnsgate 5864.

Peterman No. 1 and No. 2 Gear Cutters. Motorised.—WILCOX & CO., Barr Street, Birmingham 19. NORthern 1234/5.

5ft. Arm Jones & Shipman Radial Drilling Machine. Fully motorised 440v., 3 phase, low base type, power elevation of arm, speeds 42-1,500 r.p.m., 4 power feeds. No. 4 M.T. spindle. In fair condition. Can be inspected working by appointment. No dealers. —BOX D408, MACHINERY, Clifton House, Euston Road, N.W.1.

MARTIN
BROTHERS (MACHINERY) LTD.

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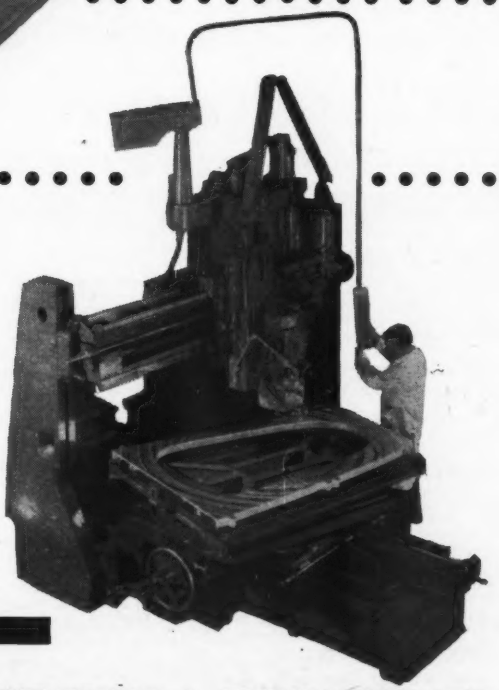

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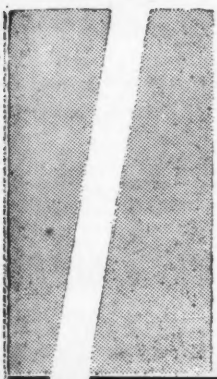

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MATTISON 36in. × 12in. Horizontal Spindle Surface Grinder, Hydraulic feeds up to 100ft. per min. Fitted 36in. × 12in. magnetic chuck, wheel size 20in. Motorised 15 h.p. 400/440-v., 3-phase, 50 cycles.

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HERBERT 7 Comb. Turret. 2in. H/Spindle. Speeds 767 r.p.m.
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MILWAUKEE 3H Horizontal Miller. Speeds—1,000. Table 63in. × 13½in.

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NORTON No. 4 Flypress.
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TAYLOR & CHALLEN 370 20 Ton O/F Power Press.
SWEENEY & BLOCKSIDGE 20 Ton O/F Power Press.
EDWARDS No. 21 40 Ton O/F Power Pres .

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NEW **RAPIDOR** 6in Power Hacksaw.
SPEEDAX 9in. Power Hacksaw.
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LATHES

DEAN, SMITH & GRACE S.S. & S.C. Gap Bed Centre Lathe, 8½in. centre height × 48in. between centres.

CAPSTAN AND CENTRE LATHES

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BROWN & SHARPE Plain Cylindrical Grinding Machine, 10in. swing × 36in. between centres.
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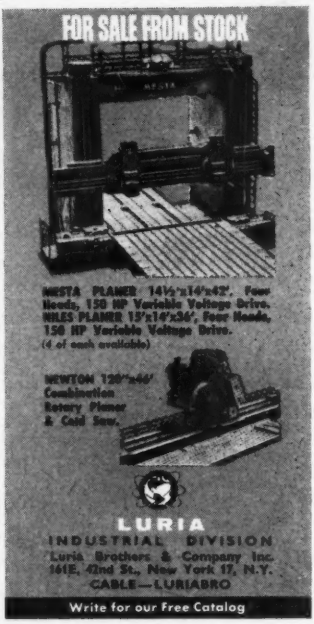
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Latest time for acceptance of classified advertisements in the following issues :—

December 20th by first post Monday December 11th
December 27th by first post Friday December 15th

After this date advertisements received Wednesday will be inserted the following Wednesday.

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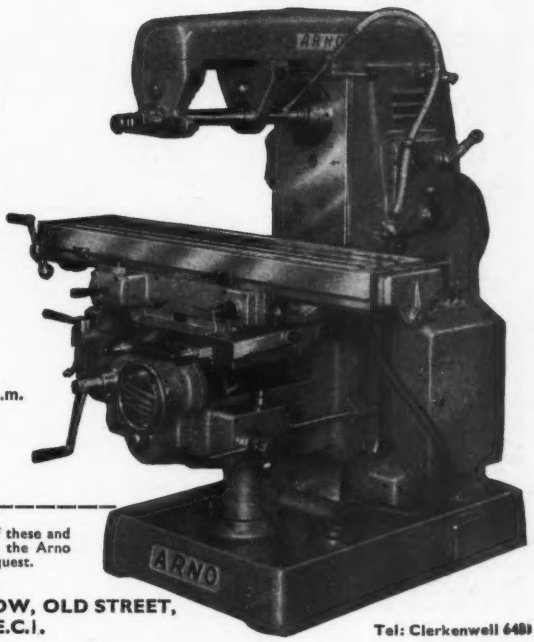

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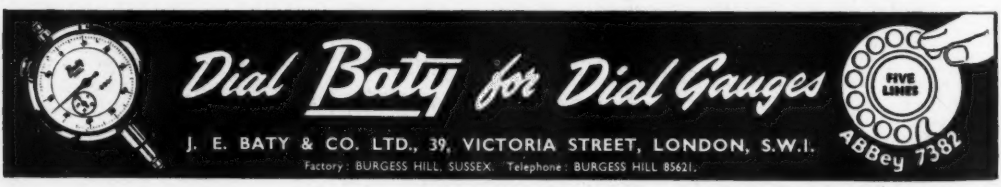
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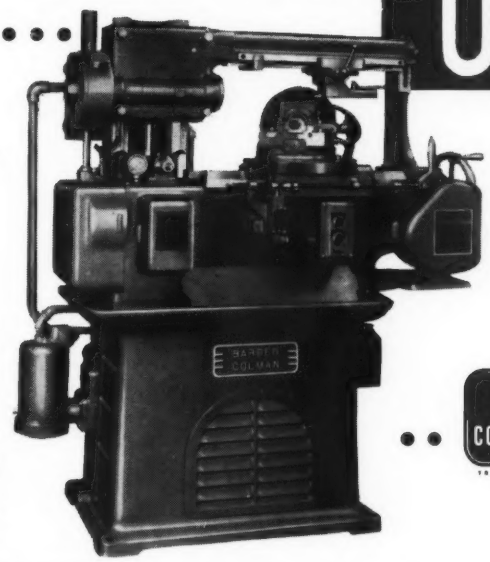

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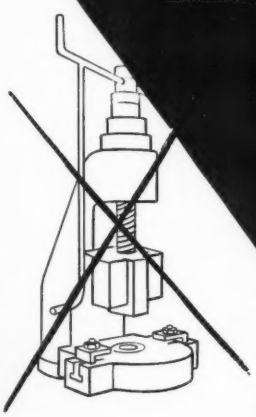

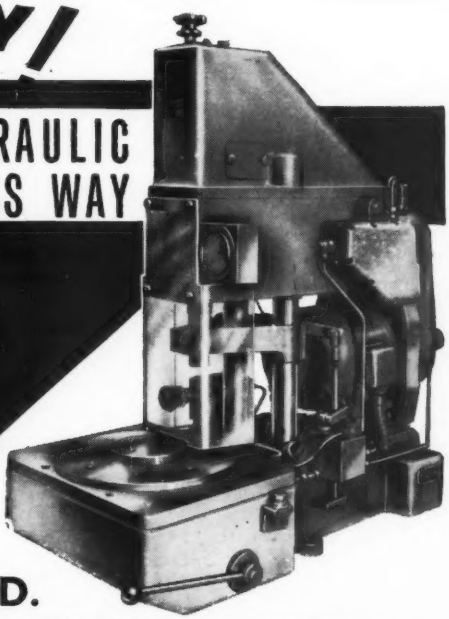

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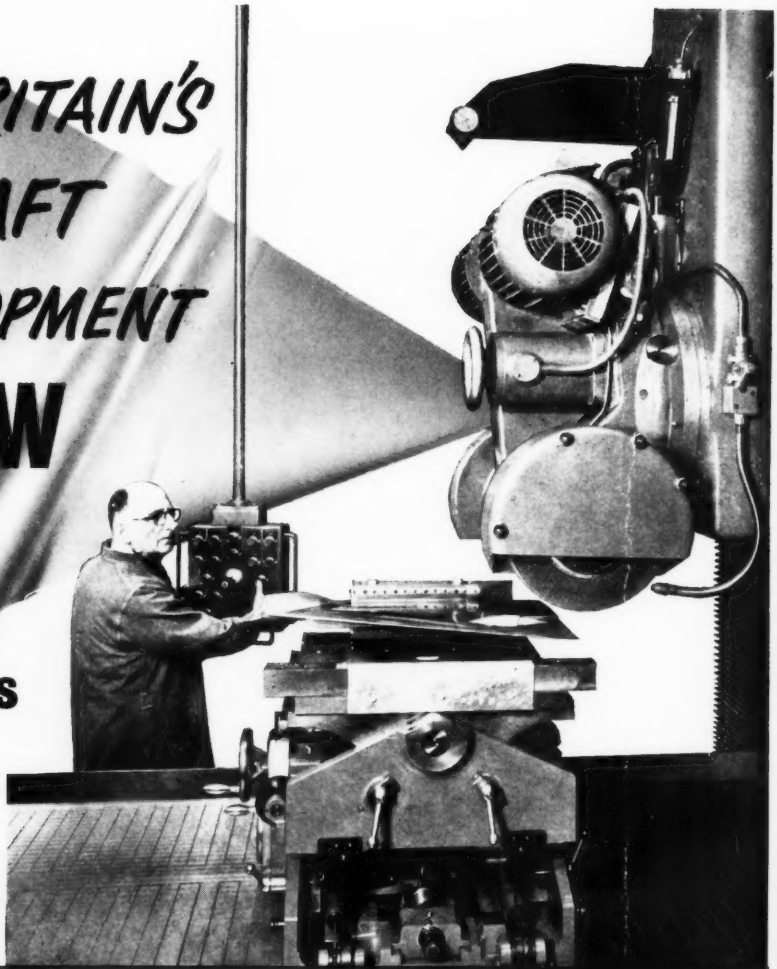

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